# XXIX. *First Analysis of One Hundred and Seventy-seven Magnetic Storms, registered by the Magnetic Instruments in the Royal Observatory, Greenwich, from* 1841 *to* 1857. *By* George Biddell Airy, *Astronomer Royal.*

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1. In a paper which the Royal Society have printed in their Philosophical Transactions for 1862, I gave a series of curves exhibiting to the eye the diurnal inequalities of Terrestrial Magnetism in the three directions of Westerly Force, Northerly Force, and Nadir Force, as inferred from eye-observations and photographic registers at the Royal Observatory from 1841 to 1857. The paper, or the works to which it refers, exhibits also the secular change and the annual inequality through that period, and the lunar inequalities as inferred from the period 1848 to 1857. These results were obtained by excluding the observations of certain days (of whch a list was given) on which the motions of the magnetometers were so violent that it was difficult to draw a mean curve through the magnetic curve of the day. In the present paper I propose to give the principal results deducible from the days omitted in the former paper. But before entering into the details of the numerical investigations, I think it desirable to explain the principles upon which both parts of the investigations have been conducted.

2. The methods commonly employed in late years for measuring and classifying the effects of magnetic disturbance have been, in my judgment, very valuable to the science, especially in its earlier stages. But familiarity through many past years with magnetic photograms has strongly impressed me with the feeling that a different method ought now to be employed, taking account of relations of disturbances which perhaps could not be known at the introduction of the ancient method. I may thus describe the general ideas which have guided me:—First, that there is no such thing as a day really free from disturbance, and no reason in the nature of things for separating one or more days from the general series. There is abundant reason for such separation on the ground of convenience of reduction; but when the reduction has been effected by suitable process, the results of the separated days ought to be combined with those of the unseparated days in the formation of general means (the numerical necessity for which I propose to consider in the close of this paper),—the reduction of the separated days serving also to throw great light upon the nature of the acting forces on those days, which forces in all probability are acting, though in different degrees, on other days. Second, that, with our present knowledge of the character of magnetic disturbances, I cannot think myself justified in separating any single magnetic indication, or any series of indications defined only by their magnitude; nor do I entertain the belief that any

special value could attach to the results which I might derive from observations from which such indications have been removed. The study of the photograms shows clearly that the successive indications at successive moments of the same day are a connected series; there is no such thing as a sudden display of force in any element; the sharpest salience which is exhibited on a generally smooth curve occupies at least an hour in its development (I believe, never less, although the individual saliences in a continued storm are of shorter duration), and during this time the force has been gradually increasing and gradually diminishing. Under these circumstances, I cannot think it right that I should cut off a part of that salience, with the belief of obtaining results, that can possess any philosophical value, from the part which is left. And I come to the conclusion that each disturbed day must be considered in its entirety, and that our attention ought to be given in the first instance to the devising of methods by which the complicated registers of each of those days, separately considered, can be rendered manageable, and in the next place to the discussion of the laws of disturbance which they may aid to reveal to us, and to the ascertaining of their effects on the general means in which they ought to be included.

3. The discrimination of the classes of days which (on the one hand) are treated by the general process in the "Results of Magnetical Observations, 1859," and of those which (on the other hand) are to be treated by the methods of this Memoir, has been effected entirely by the judgment of the Superintendent of Computations as to the certainty and accuracy with which he could draw a mean line through the disturbed curves. I do however entirely recognize the propriety of defining the "disturbed days" by some numerical limit, when it can be conveniently done: but, the day being defined, I then think that the entire disturbed day or storm ought to be treated as a coherent whole; and that the laws of disturbance and the amalgamation with general means ought to be deduced from it, as already mentioned, without reference to any numerical limit.

4. The records of disturbances from 1848 to 1857 are taken from the photograms; and the value of these, I believe, is unimpeachable. The instruments appear to have been in the highest state of efficiency; I do not think that there is the least doubt on the indications of any disturbed day. And (as the effect of adjustments made expressly for that purpose) the traces of the most violent motions are in general perfectly preserved—an advantage which is possessed, I believe in a peculiar degree, by the photograms of the Royal Observatory. Some sheets may be lost from defects in the paper, defects in the chemical process, &c.; but none, I believe, from rapidity and violence of motion of the magnets. The indications for every salient point of the curves have been translated into numbers which are printed in the "Results of Magnetical Observations" for each year; and those numbers are used as the basis of the following calculations. For the years 1841–1847, in which observations were made by eye, it will be seen in the printed Observations that no opportunity was lost, on the slightest appearance of disturbance, of following most carefully the indications of all the magnetometers: and in fact, as regards both the number of days of such observations and the number of

observations on each day, the observations taken are far more numerous than was necessary. The judgment of the Superintendent has been exercised in making such a selection of days and such a limitation of records for each day as should make the adopted register for the period 1841–1847 harmonize well with that for the period 1848–1857.

In the following investigations, whenever one instrument has exhibited such signs of disturbance that its indications were thought unfit for treatment in the former Reductions and are therefore included in this Analysis, the indications of the two other instruments are also included in this Analysis.

5. In deciding on the method of making the disturbed curves more manageable, the following was my train of ideas. As the photographic curve usually consists of a series of lines (very little curved) highly inclined to the time-abscissa and leading alternately upwards and downwards, if each of these lines be bisected and the bisecting points be joined, the joining lines will form a polygon of much less violent character than the original. If these joining lines be bisected and the bisecting points joined, we shall have a polygon of still smoother character, with angles sensibly corresponding to the original times, excepting only the first and the last. If the double process be repeated, the polygon will be still smoother, but wanting points corresponding to the two first and two last observations. And thus we shall have a mean curve containing all the long waves of the original curve, and freed from the irregularities of short period, whose values, however, can be measured. Numerically, each step of the process is represented by taking, for the numerical value of a new ordinate, the arithmetical mean of the numerical values of adjacent ordinates, or, still more easily, by adding the adjacent ordinates, adding the adjacent sums thus formed, and dividing by 4, and repeating this operation. An instance will make this process clear.

Readings for Northerly Force (corrected for temperature) in the Magnetic Storm of 1854, March 6.

| Göttingen Time. | Reading. | 1st Sum. | 2nd Sum. | $\frac{1}{4}$th. | 3rd Sum. | 4th Sum. | $\frac{1}{4}$th or Adopted. |
|---|---|---|---|---|---|---|---|
| h m | | | | | | | |
| 0 0 | ·1153 | ·2306 | | | | | |
| 1 8 | 1153 | 2322 | ·4628 | ·1157 | ·2314 | | |
| 1 32 | 1169 | 2308 | 4630 | 1157 | 2308 | ·4622 | ·1155 |
| 1 50 | 1139 | 2295 | 4603 | 1151 | 2301 | 4609 | 1152 |
| 2 7 | 1156 | 2306 | 4601 | 1150 | 2304 | 4605 | 1151 |
| 2 30 | 1150 | 2309 | 4615 | 1154 | 2309 | 4613 | 1153 |
| 2 44 | 1159 | 2312 | 4621 | 1155 | 2310 | 4619 | 1155 |
| 2 58 | 1153 | 2310 | 4622 | 1155 | 2311 | 4621 | 1155 |
| 3 30 | 1157 | 2314 | 4624 | 1156 | 2315 | 4626 | 1157 |
| 4 5 | 1157 | 2320 | 4634 | 1159 | 2320 | 4635 | 1159 |
| 4 12 | 1163 | 2323 | 4643 | 1161 | 2323 | 4643 | 1161 |
| 4 45 | 1160 | 2325 | 4648 | 1162 | 2323 | 4646 | 1161 |
| 5 23 | 1165 | 2320 | 4645 | 1161 | 2313 | 4636 | 1159 |
| 6 15 | 1155 | 2286 | 4606 | 1152 | 2298 | 4611 | 1153 |
| 6 39 | 1131 | 2299 | 4585 | 1146 | 2303 | 4601 | 1150 |
| 7 6 | 1168 | 2329 | 4628 | 1157 | 2320 | 4623 | 1156 |
| 7 15 | 1161 | 2324 | 4653 | 1163 | 2321 | 4641 | 1160 |
| 7 24 | 1163 | 2309 | 4633 | 1158 | 2310 | 4631 | 1158 |
| 7 32 | 1146 | 2299 | 4608 | 1152 | 2298 | 4608 | 1152 |
| 7 45 | 1153 | 2284 | 4583 | 1146 | 2289 | 4587 | 1147 |
| 8 25 | 1131 | 2287 | 4571 | 1143 | 2292 | 4581 | 1145 |
| 9 17 | 1156 | 2308 | 4595 | 1149 | 2305 | 4597 | 1149 |
| 9 45 | 1152 | 2316 | 4624 | 1156 | 2315 | 4620 | 1155 |
| 10 40 | 1164 | 2318 | 4634 | 1159 | 2324 | 4639 | 1160 |
| 11 23 | 1154 | 2341 | 4659 | 1165 | 2340 | 4664 | 1166 |
| 11 50 | 1187 | 2358 | 4699 | 1175 | 2350 | 4690 | 1172 |
| 12 8 | 1171 | 2343 | 4701 | 1175 | 2344 | 4694 | 1174 |
| 12 20 | 1172 | 2331 | 4674 | 1169 | 2333 | 4677 | 1169 |
| 12 39 | 1159 | 2325 | 4656 | 1164 | 2327 | 4660 | 1165 |
| 13 8 | 1166 | 2328 | 4653 | 1163 | 2325 | 4652 | 1163 |
| 13 17 | 1162 | 2320 | 4648 | 1162 | 2326 | 4651 | 1163 |
| 13 45 | 1158 | 2335 | 4655 | 1164 | 2334 | 4660 | 1165 |
| 20 0 | 1177 | 2345 | 4680 | 1170 | 2340 | 4674 | 1169 |
| 21 0 | 1168 | 2335 | 4680 | 1170 | 2336 | 4676 | 1169 |
| 22 3 | 1167 | 2328 | 4663 | 1166 | 2328 | 4664 | 1166 |
| 22 25 | 1161 | 2321 | 4649 | 1162 | 2319 | 4647 | 1162 |
| 22 46 | 1160 | 2308 | 4629 | 1157 | 2308 | 4627 | 1157 |
| 22 55 | 1148 | 2296 | 4604 | 1151 | 2291 | 4599 | 1150 |
| 23 4 | 1148 | 2265 | 4561 | 1140 | 2272 | 4563 | 1141 |
| 23 30 | 1117 | 2261 | 4526 | 1132 | | | |
| 23 59 | 1144 | | | | | | |

The Adopted Numbers are those to be compared with the Original Reading, in order to ascertain what portion of the Original Reading is to be ascribed to Irregularities: and the Adopted Numbers are also to be compared with the Monthly Means deduced from the days of easy reduction, in order to ascertain what portion is to be considered as Wave-Disturbance. Thus we finally obtain the following separation of numbers, whose aggregate represents the Original Reading:—

Component parts of Northerly Force in the Magnetic Storm of 1854, March 6.

| Göttingen Time. | Monthly Mean. | Wave-Disturbance. | | Irregularities. | |
|---|---|---|---|---|---|
| h m | | | | | |
| 1 32 | ·1158 | | −·0003 | +·0014 | |
| 1 50 | 1158 | | − 6 | | −·0013 |
| 2 7 | 1158 | | − 7 | + 5 | |
| 2 30 | 1160 | | − 7 | | − 3 |
| 2 44 | 1160 | | − 5 | + 4 | |
| 2 58 | 1161 | | − 6 | | − 2 |
| 3 30 | 1162 | | − 5 | 0 | |
| 4 5 | 1162 | | − 3 | | − 2 |
| 4 12 | 1162 | | − 1 | + 2 | |
| 4 45 | 1162 | | − 1 | | − 1 |
| 5 23 | 1162 | | − 3 | + 6 | |
| 6 15 | 1162 | | − 9 | + 2 | |
| 6 39 | 1163 | | − 13 | | − 19 |
| 7 6 | 1163 | | − 7 | + 12 | |
| 7 15 | 1163 | | − 3 | + 1 | |
| 7 24 | 1163 | | − 5 | + 5 | |
| 7 32 | 1163 | | − 11 | | − 6 |
| 7 45 | 1163 | | − 16 | + 6 | |
| 8 25 | 1163 | | − 18 | | − 14 |
| 9 17 | 1163 | | − 14 | + 7 | |
| 9 45 | 1164 | | − 9 | | − 3 |
| 10 40 | 1164 | | − 4 | + 4 | |
| 11 23 | 1164 | +·0002 | | | − 12 |
| 11 50 | 1165 | + 7 | | + 15 | |
| 12 8 | 1165 | + 9 | | | − 3 |
| 12 20 | 1165 | + 4 | | + 3 | |
| 12 39 | 1164 | + 1 | | | − 6 |
| 13 8 | 1164 | | − 1 | + 3 | |
| 13 17 | 1164 | | − 1 | | − 1 |
| 13 45 | 1164 | + 1 | | | − 7 |
| 20 0 | 1168 | + 1 | | + 8 | |
| 21 0 | 1161 | + 8 | | | − 1 |
| 22 3 | 1156 | + 10 | | + 1 | |
| 22 25 | 1156 | + 6 | | | − 1 |
| 22 46 | 1155 | + 2 | | + 3 | |
| 22 55 | 1155 | | − 5 | | − 2 |
| 23 4 | 1155 | | − 14 | + 7 | |

The disturbance of Horizontal Force is thus separated into two well-distinguished parts. One part consists of five long waves, alternately − and +. The other part consists of irregularities of short period, which do not show the least symptom of disappearing at the disappearance of the waves, and appear to have nothing in common with them except the connexion of both with the same general Magnetic Storm.

6. For fully understanding the import of these numbers, it will perhaps be necessary to study the succession of numbers in each individual instance. In this First Analysis, I have proceeded, as the first step, to take the means that appear to be most valuable. As regards the Waves, I have taken separately the mean of the wave-disturbances through each wave. But as this quantity gives little information unless taken in conjunction with the time through which it acts, I have multiplied it by the length of the wave in hours; and this product I have distinguished by the technical term *Fluctuation*. The

following is now an Epitome of the Magnetic Storm which we have had under consideration.

Epitome of Disturbances of Northerly Force in the Magnetic Storm of 1854, March 6.

| Times of beginning and end of wave. | | Length of wave in hours. | Mean Wave-disturbance. | Fluctuation. | Aggregate Fluctuation. | Sum of Hours. | Mean Disturbance. | Number of Irregularities. | Mean Period of Irregularity. | Mean value of Irregularity. |
|---|---|---|---|---|---|---|---|---|---|---|
| h m | h m | h | | | | h | | | h | |
| 0 0 | 11 1 | 11·02 | —·0007 | —·0077 | | | | 22 | 0·50 | ±·0006 |
| 11 1 | 12 54 | 1·88 | + 5 | + 9 | | | | 5 | 0·38 | 8 |
| 12 54 | 13 31 | 0·62 | — 1 | — 1 | —·0033 | 23·98 | —·0001 | 2 | 0·31 | 2 |
| 13 31 | 22 51 | 9·33 | + 5 | + 47 | | | | 6 | 1·56 | 4 |
| 22 51 | 23 59 | 1·13 | — 10 | — 11 | | | | 2 | 0·57 | 4 |

The disturbances of Westerly Force and Nadir Force are treated in the same way—the values of disturbance, &c. being converted, at convenient stages, into values expressed in terms of whole Northerly Force.

The numbers contained in these Epitomes serve as bases for the investigations which follow. The Epitomes themselves, though greatly reduced from the voluminous calculations on which they are founded, are far too extensive to be included in this Memoir: they will probably be printed in the Greenwich Observations.

7. Treating the Waves as the first subject, I take in the first instance the algebraical aggregate of the Fluctuations for each separate Magnetic Storm. In Table I., the first or longest of the three Tables which follow, every recorded storm is included; and in the second, or Table II., these are all collected to form annual aggregates. But as the days of record do not strictly coincide for the three instruments, partly from accidents in the chemical preparation of the photographic paper, &c., but more particularly from the experimental state of the Vertical-Force Instrument during a part of the year 1848, I have thought it desirable to form Table III. from the observations which are strictly comparable. In regard to the last columns of each department of Table I., and the last lines of Tables II. and III., it will be remarked that the "Fluctuation" is a product of number of hours by Magnetic Disturbance, and therefore, for the Mean Disturbance, the Aggregate of Fluctuations must be divided by the Sum of Hours.

TABLE I.—Algebraic Sums of Magnetic Fluctuations (in terms of Horizontal Force) on Days of Great Magnetic Disturbance.

| Year, Month, and Day. | Westerly Force. | | | Northerly Force. | | | Nadir Force. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Hours. | Algebraic Aggregate of Fluctuations. | Algebraic Mean of Disturbance. | Number of Hours. | Algebraic Aggregate of Fluctuations. | Algebraic Mean of Disturbance. | Number of Hours. | Algebraic Aggregate of Fluctuations. | Algebraic Mean of Disturbance. |
| 1841. | | | | | | | | | |
| Sept. 24 ...... | 13·9 | −0·0022 | − 2 | 12·0 | −0·0456 | −38 | 14·0 | −0·0392 | − 28 |
| 25 ...... | 22·0 | − ·0200 | − 9 | 12·9 | − ·0054 | − 4 | 11·3 | + ·2580 | +229 |
| 27 ...... | 8·2 | − ·0270 | −33 | 8·2 | − ·0097 | −12 | 8·2 | + ·0670 | + 82 |
| Oct. 25 ...... | 22·0 | − ·0417 | −19 | 22·0 | − ·0484 | −22 | 20·2 | + ·0226 | + 11 |
| Nov. 18 ...... | 17·9 | − ·0735 | −41 | 17·9 | − ·0125 | − 7 | 18·0 | − ·0323 | − 18 |
| 19 ...... | 22·8 | + ·0016 | + 1 | 24·0 | − ·0276 | −12 | 23·7 | − ·0379 | − 16 |
| Dec. 3 ...... | 12·7 | + ·0088 | + 7 | 12·7 | − ·0205 | −16 | 10·9 | + ·0424 | + 39 |
| 14 ...... | 10·0 | − ·0296 | −30 | 10·0 | − ·0130 | −13 | 10·0 | + ·0621 | + 62 |
| 1842. | | | | | | | | | |
| Jan. 1 ...... | 6·7 | −0·0240 | −36 | 6·7 | +0·0387 | +58 | 6·1 | +0·0061 | + 10 |
| Feb. 24 ...... | 8·0 | − ·0090 | −11 | 8·0 | − ·0400 | −50 | 8·0 | + ·0014 | + 2 |
| April 14 ...... | 7·6 | + ·0214 | +28 | 7·4 | − ·0423 | −57 | 8·0 | − ·0784 | − 98 |
| 15 ...... | 23·1 | + ·0087 | + 4 | 24·0 | − ·1416 | −59 | 22·2 | − ·0061 | − 3 |
| July 1 ...... | 7·7 | + ·0008 | + 1 | 7·7 | − ·0178 | −23 | 8·0 | + ·0135 | + 17 |
| 2 ...... | 13·6 | − ·0523 | −39 | 13·4 | − ·0138 | −10 | 13·2 | + ·0608 | + 46 |
| 3 ...... | 9·7 | − ·0003 | 0 | 10·0 | − ·0650 | −65 | 10·0 | − ·0289 | − 29 |
| Nov. 10 ...... | 14·2 | − ·0340 | −24 | 14·2 | − ·0710 | −50 | 14·2 | + ·0185 | + 13 |
| 21 ...... | 12·0 | − ·0054 | − 5 | 12·0 | − ·0132 | −11 | 12·0 | − ·0312 | − 26 |
| Dec. 9 ...... | 10·0 | − ·0220 | −22 | 10·0 | − ·0187 | −19 | 10·0 | + ·0311 | + 31 |
| 1843. | | | | | | | | | |
| Jan. 2 ...... | 10·0 | +0·0180 | +18 | 10·0 | −0·0180 | −18 | 10·0 | −0·0261 | − 26 |
| Feb. 6 ...... | 6·0 | + ·0002 | 0 | ...... | ............ | ...... | ...... | ............ | ...... |
| 16 ...... | 4·0 | − ·0044 | −11 | 4·0 | − ·0048 | −12 | ...... | ............ | ...... |
| 24 ...... | 11·6 | − ·0129 | −11 | 11·6 | − ·0189 | −16 | 11·6 | + ·0031 | + 3 |
| May 6 ...... | 4·4 | − ·0216 | −49 | 4·1 | − ·0226 | −55 | 4·2 | − ·0064 | − 16 |
| July 24 ...... | 13·7 | + ·0145 | +11 | 13·7 | − ·0227 | −17 | 14·0 | + ·0140 | + 10 |
| 25 ...... | 6·0 | + ·0210 | +35 | 6·0 | + ·0002 | 0 | 5·6 | + ·0329 | + 59 |
| 1844. | | | | | | | | | |
| Mar. 29 ...... | 15·7 | −0·0140 | − 9 | 15·7 | −0·0305 | −19 | 16·0 | −0·0448 | − 28 |
| 30 ...... | 12·0 | − ·0097 | − 8 | 12·0 | − ·0126 | −11 | 11·6 | + ·0017 | + 2 |
| Oct. 1 ...... | 6·0 | − ·0156 | −26 | 6·0 | − ·0198 | −33 | 6·0 | + ·0018 | + 3 |
| 20 ...... | ...... | ............ | ...... | 8·0 | − ·0224 | −28 | 8·0 | − ·0904 | −113 |
| Nov. 16 ...... | 10·0 | + ·0112 | +11 | 10·0 | − ·0280 | −28 | 9·7 | + ·0398 | + 41 |
| 22 ...... | 8·0 | + ·0248 | +31 | 8·0 | − ·0196 | −25 | 8·0 | − ·0052 | − 7 |
| 1845. | | | | | | | | | |
| Jan. 9 ...... | 10·0 | −0·0290 | −29 | 10·0 | −0·0440 | −44 | 10·0 | +0·080 | + 8 |
| Feb. 24 ...... | 15·7 | − ·0198 | −13 | 16·2 | − ·0177 | −11 | 16·2 | − ·0211 | − 13 |
| Mar. 26 ...... | 14·0 | − ·0210 | −15 | 14·0 | − ·0090 | − 6 | 14·0 | − ·0070 | − 5 |
| Aug. 29 ...... | 6·2 | − ·0037 | − 6 | 6·1 | − ·0024 | − 4 | 6·2 | − ·0062 | − 10 |
| Dec. 3 ...... | 14·1 | − ·0022 | − 2 | 14·2 | − ·0667 | −47 | 14·2 | + ·0439 | + 31 |
| 1846. | | | | | | | | | |
| May 12 ...... | 10·0 | −0·0009 | − 1 | 10·0 | −0·0044 | − 4 | 10·0 | −0·0040 | − 4 |
| July 11 ...... | ...... | ............ | ...... | 10·0 | − ·0092 | − 9 | 3·4 | − ·0044 | − 13 |
| Aug. 6 ...... | 11·9 | + ·0099 | + 8 | 11·9 | − ·0037 | − 3 | 12·0 | − ·0015 | − 1 |
| 7 ...... | 22·0 | + ·0286 | +13 | 22·0 | − ·0013 | − 1 | 21·9 | + ·0051 | + 2 |
| 24 ...... | 14·0 | − ·0107 | − 8 | 12·0 | − ·0036 | − 3 | 16·0 | − ·0160 | − 10 |
| 25 ...... | 16·0 | − ·0096 | − 6 | 16·0 | + ·0050 | + 3 | 14·2 | − ·0071 | − 5 |

TABLE I. (continued).

| Year, Month, and Day. | Westerly Force. | | | Northerly Force. | | | Nadir Force. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Hours. | Algebraic Aggregate of Fluctuations. | Algebraic Mean of Disturbance. | Number of Hours. | Algebraic Aggregate of Fluctuations. | Algebraic Mean of Disturbance. | Number of Hours. | Algebraic Aggregate of Fluctuations. | Algebraic Mean of Disturbance. |
| 1846 (contd). | | | | | | | | | |
| Aug. 28 ...... | 8·8 | −0·0058 | − 7 | 8·7 | −0·0075 | − 9 | 8·8 | −0·0114 | − 13 |
| Sept. 4 ...... | 15·9 | + ·0091 | + 6 | 15·8 | − ·0116 | − 7 | 16·0 | + ·0208 | + 13 |
| 5 ...... | 13·0 | + ·0056 | + 4 | 12·9 | − ·0062 | − 5 | 12·3 | + ·0274 | + 22 |
| 10 ...... | 13·9 | + ·0005 | 0 | 13·8 | + ·0029 | + 2 | 14·0 | + ·0140 | + 10 |
| 11 ...... | 23·8 | − ·0030 | − 1 | 23·8 | − ·0148 | − 6 | 23·7 | + ·0292 | + 12 |
| 21 ...... | 19·9 | − ·0286 | −14 | 19·8 | − ·0183 | − 9 | 20·0 | − ·0100 | − 5 |
| 22 ...... | 14·0 | − ·0158 | −11 | 14·0 | − ·0305 | −22 | 13·9 | + ·0225 | + 16 |
| Oct. 2 ...... | 6·0 | − ·0156 | −26 | 6·0 | − ·0102 | −17 | 6·0 | + ·0060 | + 10 |
| 7 ...... | 17·7 | − ·0073 | − 4 | 17·7 | − ·0509 | −29 | 18·0 | − ·0378 | − 21 |
| 8 ...... | 12·0 | + ·0059 | + 5 | 11·8 | − ·0227 | −19 | 11·8 | + ·0905 | + 77 |
| Nov. 26 ...... | 16·2 | − ·0069 | − 4 | 14·6 | − ·0279 | −19 | 16·2 | − ·0002 | 0 |
| Dec. 23 ...... | 10·0 | − ·0160 | −16 | 10·0 | + ·0170 | +17 | 10·0 | + ·0074 | + 7 |
| 1847. | | | | | | | | | |
| Feb. 24 ...... | 10·0 | −0·0167 | −17 | 10·0 | −0·0110 | −11 | 9·9 | −0·0030 | − 3 |
| Mar. 1 ...... | 8·0 | + ·0082 | +10 | 8·0 | − ·0047 | − 6 | 8·0 | + ·0616 | + 78 |
| 19 ...... | 20·0 | − ·0121 | − 6 | 20·0 | − ·0846 | −42 | 18·2 | − ·0783 | − 43 |
| April 3 ...... | 8·0 | − ·0240 | −30 | 8·0 | − ·0061 | − 8 | 8·0 | + ·0264 | + 33 |
| 7 ...... | 16·0 | − ·0046 | − 3 | 16·0 | − ·0493 | −31 | 16·0 | − ·0171 | − 11 |
| 21 ...... | 6·0 | + ·0004 | + 1 | 5·5 | − ·0120 | −22 | 6·0 | + ·0156 | + 26 |
| May 7 ...... | 8·0 | + ·0344 | +43 | 8·0 | − ·0032 | − 4 | 10·0 | − ·0100 | − 10 |
| June 24 ...... | 4·0 | + ·0109 | +27 | ...... | ............ | ...... | ...... | ............ | ...... |
| July 9 ...... | ...... | ............ | ...... | 4·0 | − ·0352 | −88 | 4·0 | − ·0464 | −116 |
| Sept. 24 ...... | 18·0 | + ·0082 | + 5 | 18·0 | + ·0332 | +18 | 17·0 | + ·0435 | + 26 |
| 26 ...... | 9·8 | − ·0159 | −16 | 9·8 | − ·0401 | −41 | 10·0 | − ·0260 | − 26 |
| 27 ...... | 10·0 | + ·0008 | + 1 | 10·0 | − ·0300 | −30 | 9·7 | + ·0603 | + 62 |
| Oct. 22 ...... | 5·8 | + ·0033 | + 6 | 5·8 | − ·0403 | −70 | 6·0 | − ·0108 | − 18 |
| 23*(1st) | 12·0 | + ·0091 | + 8 | 12·0 | − ·0132 | −11 | 11·6 | + ·0988 | + 85 |
| 23 (2nd) | 2·0 | − ·0025 | −13 | 1·9 | − ·0030 | −16 | 2·0 | + ·0016 | + 8 |
| 24 ...... | 23·3 | + ·0137 | + 6 | 23·3 | − ·2088 | −90 | 23·7 | + ·0538 | + 23 |
| 25 ...... | 10·0 | − ·0093 | − 9 | 10·0 | − ·0150 | −15 | 9·5 | + ·0654 | + 69 |
| Nov. 22 ...... | 14·0 | + ·0120 | + 9 | 14·0 | − ·0304 | −22 | 15·2 | − ·0421 | − 28 |
| Dec. 17 ...... | 22·0 | + ·0157 | + 7 | 22·0 | − ·0268 | −12 | 14·0 | + ·1260 | + 90 |
| 18 ...... | 12·0 | − ·0120 | −10 | 12·0 | − ·0193 | −16 | ...... | ............ | ...... |
| 19 ...... | 10·0 | + ·0175 | +17 | 10·0 | − ·0910 | −91 | ...... | ............ | ...... |
| 20 ...... | 18·0 | − ·0132 | − 7 | 18·0 | − ·0581 | −32 | ...... | ............ | ...... |
| 1848. | | | | | | | | | |
| Jan. 16 ...... | 14·2 | −0·0047 | − 3 | 10·3 | −0·0340 | −33 | ...... | ............ | ...... |
| 28 ...... | 14·0 | − ·0210 | −15 | 19·1 | + ·0217 | +11 | ...... | ............ | ...... |
| Feb. 20 ...... | 22·5 | − ·0192 | − 9 | 9·1 | − ·0335 | −37 | ...... | ............ | ...... |
| 21 ...... | 16·9 | + ·0047 | + 3 | 22·8 | − ·0742 | −33 | ...... | ............ | ...... |
| 22 ...... | 4·0 | − ·0043 | −10 | 4·0 | − ·0125 | −31 | ...... | ............ | ...... |
| 23 ...... | 18·0 | − ·0113 | − 6 | 8·6 | − ·0024 | − 3 | ...... | ............ | ...... |
| 24 ...... | 20·8 | + ·0335 | +16 | 22·8 | − ·0503 | −22 | ...... | ............ | ...... |
| Mar. 17 ...... | 3·3 | + ·0077 | +23 | 5·2 | − ·0067 | −13 | ...... | ............ | ...... |
| 20 ...... | 14·2 | − ·0126 | − 9 | 11·5 | − ·0309 | −27 | ...... | ............ | ...... |
| April 7 ...... | 11·4 | + ·0045 | + 4 | 4·1 | − ·0074 | −18 | ...... | ............ | ...... |
| May 18 ...... | 9·1 | − ·0016 | − 2 | 8·4 | + ·0105 | +12 | ...... | ............ | ...... |
| July 11 ...... | 16·4 | − ·0054 | − 3 | 19·4 | − ·0415 | −21 | ...... | ............ | ...... |
| Oct. 18 ...... | 11·5 | + ·0024 | + 2 | 10·6 | − ·0271 | −26 | 7·1 | −0·0970 | −136 |

* On October 23, 1847, all the observations were interrupted during 10 hours.

TABLE I. (continued).

| Year, Month, and Day. | Westerly Force. Number of Hours. | Westerly Force. Algebraic Aggregate of Fluctuations. | Westerly Force. Algebraic Mean of Disturbance. | Northerly Force. Number of Hours. | Northerly Force. Algebraic Aggregate of Fluctuations. | Northerly Force. Algebraic Mean of Disturbance. | Nadir Force. Number of Hours. | Nadir Force. Algebraic Aggregate of Fluctuations. | Nadir Force. Algebraic Mean of Disturbance. |
|---|---|---|---|---|---|---|---|---|---|
| 1848 (contd.) | | | | | | | | | |
| Oct. 23 …… | 10·6 | −0·0060 | − 6 | 9·9 | −0·0066 | − 7 | …… | ……… | …… |
| 25 …… | 17·5 | − ·0034 | − 2 | 18·5 | + ·0025 | + 1 | …… | ……… | …… |
| 29 …… | 16·1 | − ·0041 | − 2 | 4·4 | ·0000 | 0 | …… | ……… | …… |
| Nov. 17 …… | 20·0 | − ·0003 | − 0 | 19·3 | − ·1955 | −101 | 18·9 | +0·0601 | + 32 |
| 18 …… | 14·2 | − ·0266 | −19 | 10·3 | − ·0201 | − 20 | 4·2 | + ·0208 | + 50 |
| Dec. 17 …… | 9·5 | + ·0011 | + 1 | 5·5 | − ·0194 | − 35 | 10·3 | − ·0744 | − 72 |
| 1849. | | | | | | | | | |
| Oct. 30 …… | 22·9 | −0·0129 | − 6 | 22·8 | −0·0160 | − 7 | 22·9 | −0·3484 | −152 |
| Nov. 27 …… | 23·1 | + ·0291 | +13 | 22·4 | − ·0258 | − 12 | …… | ……… | …… |
| 1850. | | | | | | | | | |
| Feb. 22 …… | 23·7 | −0·0076 | − 3 | 23·5 | −0·0088 | − 4 | 23·3 | +0·2030 | + 87 |
| 23 …… | 23·6 | + ·0034 | + 1 | 23·3 | − ·0327 | − 14 | 23·5 | − ·0279 | − 12 |
| Mar. 31 …… | 23·9 | − ·0104 | − 4 | 23·5 | − ·0375 | − 16 | 23·3 | ·0000 | 0 |
| May 7 …… | …… | ……… | …… | 23·9 | − ·0021 | − 1 | …… | ……… | …… |
| June 13 …… | 24·0 | − ·0249 | −10 | 23·4 | − ·0062 | − 3 | 23·7 | − ·3882 | −164 |
| Oct. 1 …… | 23·2 | + ·0487 | +21 | 22·7 | − ·0522 | − 23 | 22·0 | − ·1188 | − 54 |
| 2 …… | 23·5 | + ·0401 | +17 | 23·6 | − ·0495 | − 21 | 22·6 | − ·0098 | − 4 |
| 1851. | | | | | | | | | |
| Jan. 16 …… | 23·6 | −0·0244 | −10 | 23·4 | +0·0125 | + 5 | 22·9 | −0·1009 | − 44 |
| 19 …… | 24·0 | + ·0175 | + 7 | 24·0 | + ·0328 | + 14 | 23·2 | − ·1367 | − 59 |
| Feb. 18 …… | 23·1 | + ·0082 | + 4 | 23·1 | − ·0287 | − 12 | 23·4 | + ·1382 | + 59 |
| Sept. 3 …… | 18·6 | + ·0451 | +24 | 23·4 | − ·0426 | − 18 | 23·3 | + ·1004 | + 43 |
| 4 …… | 23·4 | + ·0168 | + 6 | 23·9 | − ·0232 | − 9 | 23·0 | + ·1769 | + 77 |
| 6 …… | 24·0 | − ·0465 | −19 | 23·8 | − ·0238 | − 10 | 23·4 | − ·0508 | − 22 |
| 7 …… | 23·0 | − ·0052 | − 2 | 23·9 | − ·0576 | − 24 | 23·8 | − ·0481 | − 20 |
| 29 …… | 22·7 | − ·0550 | −24 | 23·9 | − ·0474 | − 20 | 22·4 | − ·3838 | −171 |
| Oct. 2 …… | 23·7 | + ·0037 | + 2 | 24·0 | − ·0632 | − 26 | 23·6 | − ·1364 | − 58 |
| 28 …… | 23·1 | + ·0152 | + 7 | 22·7 | − ·0244 | − 11 | 22·9 | − ·1834 | − 80 |
| Dec. 6 …… | 23·3 | − ·0307 | −13 | 23·4 | − ·1264 | − 54 | 22·6 | + ·0815 | + 36 |
| 28 …… | 23·2 | + ·0083 | + 4 | 23·9 | − ·0217 | − 9 | 23·2 | − ·0950 | − 41 |
| 29 …… | 18·5 | − ·0360 | −20 | 22·4 | − ·0627 | − 28 | 21·4 | + ·0191 | + 9 |
| 1852. | | | | | | | | | |
| Jan. 4 …… | 23·8 | +0·0245 | +10 | 22·0 | +0·0968 | + 44 | 23·5 | −0·0137 | − 6 |
| 19 …… | 22·6 | + ·0073 | + 3 | 23·2 | − ·0336 | − 14 | 22·3 | − ·1206 | − 54 |
| Feb. 14 …… | 22·3 | − ·0073 | − 3 | 23·2 | + ·0771 | + 33 | 22·1 | − ·0229 | − 10 |
| 15 …… | 23·7 | + ·0006 | 0 | 23·7 | − ·0150 | − 6 | 23·4 | − ·1763 | − 75 |
| 17 …… | 23·3 | − ·0021 | − 1 | 23·5 | − ·0449 | − 19 | 23·0 | + ·2517 | +109 |
| 18 …… | 23·9 | + ·0031 | + 1 | 23·7 | − ·0587 | − 25 | 23·9 | + ·4422 | +185 |
| 19 …… | 21·0 | − ·0261 | −12 | 23·5 | − ·0492 | − 21 | 23·0 | − ·2596 | −113 |
| 20 …… | 22·9 | − ·0078 | − 3 | 23·7 | − ·0371 | − 16 | 23·1 | − ·1594 | − 69 |
| 21 …… | 20·0 | − ·0186 | − 9 | 23·8 | − ·0604 | − 25 | 22·5 | − ·1735 | − 77 |
| April 20 …… | 23·9 | + ·0226 | + 9 | 24·0 | − ·0790 | − 33 | 22·5 | − ·1508 | − 67 |
| May 19 …… | 16·0 | − ·0485 | −30 | 23·5 | + ·0047 | + 2 | 21·3 | + ·0595 | + 28 |
| 20 …… | 6·8 | − ·0068 | −10 | 23·4 | − ·0068 | − 3 | 13·8 | + ·0605 | + 44 |
| June 11 …… | 22·5 | − ·0030 | − 1 | 23·5 | − ·0310 | − 13 | 22·3 | − ·4354 | −195 |
| 16 …… | 23·3 | − ·0126 | − 5 | 23·5 | + ·0177 | + 8 | …… | …… | …… |
| July 10 …… | 21·1 | − ·0362 | −17 | 21·3 | + ·0042 | + 2 | 22·3 | − ·0302 | − 14 |
| Nov. 11 …… | 23·9 | + ·0057 | + 2 | 23·2 | − ·0235 | − 10 | 23·0 | − ·3236 | −141 |
| 13 …… | 23·7 | + ·0114 | + 5 | 23·3 | − ·0352 | − 15 | 21·3 | − ·1638 | − 77 |

TABLE I. (continued).

| Year, Month, and Day. | Westerly Force. Number of Hours. | Westerly Force. Algebraic Aggregate of Fluctuations. | Westerly Force. Algebraic Mean of Disturbance. | Northerly Force. Number of Hours. | Northerly Force. Algebraic Aggregate of Fluctuations. | Northerly Force. Algebraic Mean of Disturbance. | Nadir Force. Number of Hours. | Nadir Force. Algebraic Aggregate of Fluctuations. | Nadir Force. Algebraic Mean of Disturbance. |
|---|---|---|---|---|---|---|---|---|---|
| 1853. | | | | | | | | | |
| Jan. 10 ...... | 22·7 | −0·0063 | − 3 | 22·6 | −0·0200 | − 9 | ...... | ......... | ...... |
| Mar. 7 ...... | 23·8 | − ·0171 | − 7 | 23·9 | − ·0224 | − 9 | 23·8 | +0·3353 | +141 |
| 8 ...... | 23·0 | − ·0073 | − 3 | 23·9 | − ·0072 | − 3 | 22·5 | + ·5298 | +236 |
| 11 ...... | ...... | ......... | ...... | 23·9 | − ·0253 | −11 | 23·2 | + ·3529 | +152 |
| May 2 ...... | 22·0 | − ·0101 | − 5 | 23·5 | − ·0657 | −28 | 22·9 | + ·3595 | +157 |
| 3 ...... | 23·7 | − ·0074 | − 3 | 23·7 | − ·0552 | −23 | 23·0 | + ·3424 | +149 |
| 24 ...... | 23·3 | + ·0092 | + 4 | 23·6 | + ·0300 | +13 | 23·7 | + ·2269 | + 96 |
| June 22 ...... | 23·8 | − ·0157 | − 7 | 23·7 | − ·0029 | − 1 | 23·2 | − ·1487 | − 64 |
| July 12 ...... | 23·8 | − ·0019 | − 1 | 24·0 | − ·0090 | − 4 | 23·4 | + ·0097 | + 4 |
| Aug. 21 ...... | ...... | ......... | ...... | ...... | ......... | ...... | 23·7 | − ·0617 | − 26 |
| Sept. 1 ...... | 23·5 | + ·0220 | + 9 | 22·8 | − ·0032 | − 1 | 23·5 | − ·0550 | − 23 |
| 2 ...... | 23·6 | + ·0037 | + 2 | 23·9 | − ·0616 | −26 | 23·7 | + ·0331 | + 14 |
| Oct. 1 ...... | ...... | ......... | ...... | 24·0 | − ·0312 | −13 | ...... | ......... | ...... |
| 2 ...... | ...... | ......... | ...... | 24·0 | − ·0336 | −14 | ...... | ......... | ...... |
| 25 ...... | 23·5 | − ·0119 | − 5 | 24·0 | − ·0092 | − 4 | 24·0 | + ·3093 | +129 |
| Nov. 9 ...... | 23·5 | + ·0037 | + 2 | 23·7 | − ·0474 | −20 | 23·5 | − ·0578 | − 25 |
| Dec. 6 ...... | 23·5 | + ·0134 | + 6 | 24·0 | − ·1079 | −45 | 23·3 | + ·0183 | + 8 |
| 21 ...... | 23·4 | + ·0044 | + 2 | 23·0 | − ·0071 | − 3 | 23·3 | − ·1790 | − 77 |
| 1854. | | | | | | | | | |
| Jan. 8 ...... | 23·8 | +0·0029 | + 1 | 23·4 | +0·0246 | +11 | 23·7 | −0·1089 | − 46 |
| 20*...... | 23·9 | − ·0043 | − 2 | 23·5 | − ·0096 | − 4 | 7·0 | − ·0104 | − 15 |
| (resumed) 20 ...... | ...... | ........... | ...... | ...... | ........... | ...... | 14·1 | − ·0550 | − 39 |
| Feb. 16 ...... | 23·8 | − ·0209 | − 9 | 24·0 | − ·0337 | −14 | 23·8 | − ·1165 | − 49 |
| 24 ...... | 23·9 | − ·0145 | − 6 | 23·3 | + ·0020 | + 1 | 23·7 | − ·1414 | − 60 |
| 25 ...... | 23·9 | + ·0049 | + 2 | 23·9 | + ·0119 | + 5 | 23·7 | + ·0812 | + 34 |
| Mar. 6 ...... | 23·9 | − ·0084 | − 4 | 24·0 | − ·0033 | − 1 | 23·9 | − ·1049 | − 44 |
| 15 ...... | 23·7 | − ·0099 | − 4 | 24·0 | − ·0261 | −11 | 23·3 | − ·0030 | − 1 |
| 16 ...... | 23·5 | − ·0034 | − 1 | 24·0 | − ·0408 | −17 | 23·7 | + ·0498 | + 21 |
| 28 ...... | 23·8 | − ·0114 | − 5 | 24·0 | − ·1271 | −53 | 22·7 | + ·1451 | + 64 |
| April 10 ...... | 23·9 | − ·0076 | − 3 | 23·9 | − ·0123 | − 5 | 22·6 | − ·0851 | − 38 |
| 23 ...... | 23·6 | + ·0103 | + 4 | 24·0 | − ·0196 | − 8 | 23·7 | + ·0207 | + 9 |
| May 25 ...... | 23·6 | + ·0004 | 0 | 24·0 | + ·0176 | + 7 | 23·9 | − ·0653 | − 27 |
| 1855. | | | | | | | | | |
| Mar. 12 ...... | 24·0 | −0·0117 | − 5 | 23·4 | −0·0506 | −22 | 23·5 | −0·2111 | − 90 |
| April 4 ...... | 23·6 | − ·0028 | − 1 | 23·6 | − ·0108 | − 5 | 20·3 | − ·0018 | − 1 |
| July 19 ...... | ...... | ........... | ...... | 22·8 | − ·0263 | −12 | 23·5 | − ·0101 | − 4 |
| Oct. 18 ...... | 23·7 | − ·0052 | − 2 | 24·0 | − ·0477 | −20 | 23·8 | + ·1049 | + 44 |
| † | | | | | | | | | |
| 1857. | | | | | | | | | |
| Feb. 26 ...... | 22·6 | +0·0014 | + 1 | 22·6 | −0·0086 | − 4 | 23·2 | −0·1368 | − 59 |
| Mar. 13 ...... | 23·2 | + ·0052 | + 2 | ...... | ........... | ...... | ...... | ........... | ...... |
| May 7 ...... | 24·0 | + ·0207 | + 9 | 24·0 | − ·0418 | −17 | 22·6 | − ·3191 | −141 |
| 10 ...... | 23·8 | + ·0056 | + 2 | 22·1 | + ·0270 | +12 | 24·0 | − ·0147 | − 6 |
| Sept. 3 ...... | 24·0 | − ·0124 | − 5 | 24·0 | − ·0259 | −11 | 24·0 | − ·4177 | −174 |
| Nov. 12 ...... | 23·3 | + ·0163 | + 7 | 23·3 | − ·0006 | 0 | ...... | ........... | ...... |
| 16 ...... | 21·3 | − ·0073 | − 3 | 23·3 | − ·0036 | − 2 | ...... | ........... | ...... |
| 17 ...... | 22·8 | − ·0049 | − 2 | 22·5 | − ·0277 | −12 | ...... | ........... | ...... |
| Dec. 16 ...... | 24·0 | − ·0021 | − 1 | 24·0 | − ·0304 | −13 | 24·0 | − ·2230 | − 93 |
| 17 ...... | 22·8 | − ·0086 | − 4 | 22·6 | − ·0881 | −39 | 24·0 | + ·0427 | + 18 |

* On Jan. 20, 1854, the observations of the Vertical-Force Instrument were interrupted during 3 hours.

† In 1856 there were no days of Great Magnetic Disturbance throughout the year.

The last figure in the "Algebraic Mean of Disturbance" is in the fourth decimal place of Horizontal Force.

TABLE II.—Algebraic Sums of Magnetic Fluctuations (in terms of Horizontal Force) for each Year from 1841 to 1857, including all days of Record of Great Magnetical Disturbance.

| Year. | Westerly Force. | | | Northerly Force. | | | Nadir Force. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Hours. | Algebraic Aggregate of Fluctuations. | Algebraic Mean of Disturbance. | Number of Hours. | Algebraic Aggregate of Fluctuations. | Algebraic Mean of Disturbance. | Number of Hours. | Algebraic Aggregate of Fluctuations. | Algebraic Mean of Disturbance. |
| 1841 | 129·47 | −·1836 | −14 | 119·63 | − ·1827 | −15 | 116·19 | + ·3427 | + 29 |
| 1842 | 112·57 | −·1161 | −10 | 113·34 | − ·3847 | −34 | 111·74 | − ·0132 | − 1 |
| 1843 | 55·72 | +·0148 | + 3 | 49·39 | − ·0868 | −18 | 45·40 | + ·0175 | + 4 |
| 1844 | 51·74 | −·0033 | − 1 | 59·70 | − ·1329 | −22 | 59·29 | − ·0971 | − 16 |
| 1845 | 60·00 | −·0757 | −13 | 60·41 | − ·1398 | −23 | 60·52 | + ·0176 | + 3 |
| 1846 | 244·86 | −·0606 | − 2 | 250·89 | − ·1979 | − 8 | 247·99 | + ·1305 | + 5 |
| 1847 | 246·75 | +·0239 | + 1 | 246·29 | − ·7489 | −30 | 198·75 | + ·3193 | + 16 |
| 1848 | 264·18 | −·0666 | − 3 | 223·83 | − ·5274 | −24 | 40·65 | − ·0905 | − 22 |
| 1849 | 46·00 | +·0162 | + 4 | 45·25 | − ·0418 | − 9 | 22·92 | − ·3484 | −152 |
| 1850 | 141·79 | +·0493 | + 3 | 163·80 | − ·1890 | −12 | 138·34 | − ·3417 | − 25 |
| 1851 | 294·04 | −·0830 | − 3 | 305·70 | − ·4764 | −16 | 299·17 | − ·6190 | − 21 |
| 1852 | 364·65 | −·0938 | − 3 | 395·76 | − ·2739 | − 7 | 353·07 | −1·2159 | − 34 |
| 1853 | 327·14 | −·0213 | − 1 | 402·06 | − ·4789 | −12 | 350·67 | +2·0150 | + 57 |
| 1854 | 285·10 | −·0619 | − 2 | 285·82 | − ·2164 | − 8 | 279·75 | − ·3937 | − 14 |
| 1855 | 71·37 | −·0197 | − 3 | 93·75 | − ·1354 | −14 | 91·03 | − ·1181 | − 13 |
| 1856 | 0·00 | ·0000 | ...... | 0·00 | ·0000 | ...... | 0·00 | ·0000 | ...... |
| 1857 | 231·53 | +·0139 | + 1 | 208·37 | − ·1997 | −10 | 141·73 | −1·0686 | − 75 |
| Sum ......... | 2926·91 | −·6675 | | 3023·99 | −4·4126 | | 2557·21 | −1·4636 | |
| Mean Disturbance | | −·00023 | | | − ·00146 | | | − ·00057 | |

TABLE III.—Algebraic Sums of Magnetic Fluctuations (in terms of Horizontal Force) for each Year from 1841 to 1857, including only those days of Great Magnetic Disturbance in which Records were made by the three Instruments.

| Year. | Westerly Force. | | | Northerly Force. | | | Nadir Force. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Hours. | Algebraic Aggregate of Fluctuations. | Algebraic Mean of Disturbance. | Number of Hours. | Algebraic Aggregate of Fluctuations. | Algebraic Mean of Disturbance. | Number of Hours. | Algebraic Aggregate of Fluctuations. | Algebraic Mean of Disturbance. |
| 1841 | 129·47 | −·1836 | −14 | 119·63 | − ·1827 | −15 | 116·19 | + ·3427 | + 29 |
| 1842 | 112·57 | −·1161 | −10 | 113·34 | − ·3847 | −34 | 111·74 | − ·0132 | − 1 |
| 1843 | 45·72 | +·0190 | + 4 | 45·39 | − ·0820 | −18 | 45·40 | + ·0175 | + 4 |
| 1844 | 51·74 | −·0033 | − 1 | 51·70 | − ·1105 | −22 | 51·29 | − ·0067 | − 1 |
| 1845 | 60·00 | −·0757 | −13 | 60·41 | − ·1398 | −23 | 60·52 | + ·0176 | + 3 |
| 1846 | 244·86 | −·0606 | − 2 | 240·89 | − ·1887 | − 8 | 244·61 | + ·1349 | + 5 |
| 1847 | 202·69 | +·0207 | + 1 | 202·19 | − ·5453 | −27 | 194·75 | + ·3657 | + 19 |
| 1848 | 55·17 | −·0234 | − 4 | 45·74 | − ·2621 | −58 | 40·65 | − ·0905 | − 22 |
| 1849 | 22·92 | −·0129 | − 6 | 22·84 | − ·0160 | − 7 | 22·92 | − ·3484 | −152 |
| 1850 | 141·79 | +·0493 | + 3 | 139·88 | − ·1869 | −13 | 138·34 | − ·3417 | − 25 |
| 1851 | 294·04 | −·0830 | − 3 | 305·70 | − ·4764 | −16 | 299·17 | − ·6190 | − 21 |
| 1852 | 341·34 | −·0812 | − 2 | 372·27 | − ·2612 | − 7 | 353·07 | −1·2159 | − 34 |
| 1853 | 304·41 | −·0150 | − 1 | 308·40 | − ·3688 | −12 | 303·72 | +1·7238 | + 57 |
| 1854 | 285·10 | −·0619 | − 2 | 285·82 | − ·2164 | − 8 | 279·75 | − ·3937 | − 14 |
| 1855 | 71·37 | −·0197 | − 3 | 70·97 | − ·1091 | −14 | 67·58 | − ·1080 | − 16 |
| 1856 | 0·00 | ·0000 | 0 | 0·00 | ·0000 | 0 | 0·00 | ·0000 | 0 |
| 1857 | 141·04 | +·0046 | 0 | 139·26 | − ·1678 | −12 | 141·73 | −1·0686 | − 75 |
| Sum ......... | 2504·23 | −·6428 | | 2524·42 | −3·6984 | | 2471·43 | −1·6035 | |
| Mean Disturbance | | −·00026 | | | − ·00147 | | | − ·00065 | |

8. The most remarkable of the results of these Tables is, not only that upon the whole the Algebraic Aggregate of Fluctuations for the Northerly Force is negative (which has been previously recognized), but that it is negative in every separate year. It will be seen in Table I. that on some separate days the Aggregate of Fluctuations is positive, but the number of days is only 22, in opposition to 155 with negative Aggregates.

The Aggregate for the Westerly Force is also negative: and though the different years do not consent in the same way as for the Northerly Force, yet their discordance is not so great as to justify us in setting aside this indication, although there may be greater doubt upon the accuracy of its value. This Aggregate (taken in comparison with that for the Northerly Force) appears to show that, on the whole, the direction of Disturbing Force is 10° to the East of South.

The Aggregate for the Nadir Force appears greater, but it is very uncertain; it might be nearly destroyed by the omission of a single year.

9. These characteristics of the directions of the disturbing forces will appear also in the following enumeration of the instances in which the first and last waves of each Magnetic Storm are affected in different ways. In comparing the numbers it must be borne in mind that, when there is only one wave, that wave is considered, in different places, both as the first and the last.

| | Westerly Force. | Northerly Force. | Nadir Force. |
|---|---|---|---|
| Whole number of positive fluctuations ..................... | 340 | 177 | 118 |
| of negative fluctuations ..................... | 302 | 277 | 120 |
| Number of instances in which the first wave is +......... | 106 | 58 | 81 |
| in which the first wave is −......... | 62 | 114 | 64 |
| in which the last wave is +......... | 100 | 15 | 63 |
| in which the last wave is −......... | 68 | 157 | 82 |

| | | |
|---|---|---|
| Number of Storms | beginning with Westerly Force+ and Northerly Force + . . | 35 |
| | beginning with Westerly Force+ and Northerly Force − . . | 68 |
| | beginning with Westerly Force− and Northerly Force + . . | 21 |
| | beginning with Westerly Force− and Northerly Force − . . | 40 |
| | ending with Westerly Force+ and Northerly Force + . . | 7 |
| | ending with Westerly Force+ and Northerly Force − . . | 90 |
| | ending with Westerly Force− and Northerly Force + . . | 8 |
| | ending with Westerly Force− and Northerly Force − . . | 58 |
| Number of Storms | beginning with Northerly Force+and Nadir Force + . . . | 26 |
| | beginning with Northerly Force+and Nadir Force − . . . | 21 |
| | beginning with Northerly Force−and Nadir Force + . . . | 55 |
| | beginning with Northerly Force−and Nadir Force − . . . | 42 |
| | ending with Northerly Force+and Nadir Force + . . . | 6 |
| | ending with Northerly Force+and Nadir Force − . . . | 7 |
| | ending with Northerly Force−and Nadir Force + . . . | 57 |
| | ending with Northerly Force−and Nadir Force − . . . | 74 |

10. The following Tables, Tables IV., V., and VI., exhibit the Aggregates of Fluctuations without regard of sign. They are required in order to give information on the Mean Value of Disturbance by Wave in each of the three directions.

TABLE IV.—Absolute Sums, without regard of sign, of Magnetic Fluctuations (in terms of Horizontal Force) on Days of Great Magnetic Disturbance.

| Year, Month, and Day. | Westerly Force. | | | Northerly Force. | | | Nadir Force. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Waves. | Absolute Aggregate of Fluctuations. | Absolute Mean of Disturbance. | Number of Waves. | Absolute Aggregate of Fluctuations. | Absolute Mean of Disturbance. | Number of Waves. | Absolute Aggregate of Fluctuations. | Absolute Mean of Disturbance. |
| **1841.** | | | | | | | | | |
| Sept. 24 ...... | 2 | 0·0292 | 21 | 1 | 0·0456 | 38 | 1 | 0·0392 | 28 |
| 25 ...... | 6 | ·0608 | 28 | 2 | ·0846 | 66 | 1 | ·2580 | 228 |
| 27 ...... | 1 | ·0270 | 33 | 3 | ·0101 | 12 | 1 | ·0670 | 82 |
| Oct. 25 ...... | 4 | ·0427 | 19 | 1 | ·0484 | 22 | 2 | ·0434 | 21 |
| Nov. 18 ...... | 2 | ·0961 | 54 | 1 | ·0125 | 7 | 3 | ·0517 | 29 |
| 19 ...... | 5 | ·0214 | 9 | 3 | ·0292 | 12 | 2 | ·0505 | 21 |
| Dec. 3 ...... | 3 | ·0152 | 12 | 3 | ·0207 | 16 | 1 | ·0424 | 39 |
| 14 ...... | 2 | ·0312 | 31 | 1 | ·0130 | 13 | 1 | ·0621 | 62 |
| **1842.** | | | | | | | | | |
| Jan. 1 ...... | 1 | 0·0240 | 36 | 1 | 0·0387 | 58 | 1 | 0·0061 | 10 |
| Feb. 24 ...... | 3 | ·0148 | 19 | 1 | ·0400 | 50 | 2 | ·0044 | 5 |
| April 14 ...... | 1 | ·0214 | 28 | 1 | ·0423 | 57 | 1 | ·0784 | 98 |
| 15 ...... | 3 | ·0311 | 13 | 1 | ·1416 | 59 | 2 | ·0465 | 21 |
| July 1 ...... | 4 | ·0100 | 13 | 1 | ·0178 | 23 | 3 | ·0137 | 17 |
| 2 ...... | 1 | ·0523 | 31 | 5 | ·0292 | 22 | 1 | ·0608 | 46 |
| 3 ...... | 2 | ·0283 | 29 | 1 | ·0650 | 65 | 2 | ·0545 | 55 |
| Nov. 10 ...... | 1 | ·0340 | 24 | 1 | ·0710 | 50 | 1 | ·0185 | 13 |
| 21 ...... | 2 | ·0320 | 27 | 3 | ·0248 | 21 | 1 | ·0312 | 26 |
| Dec. 9 ...... | 1 | ·0220 | 22 | 3 | ·0189 | 19 | 1 | ·0311 | 31 |
| **1843.** | | | | | | | | | |
| Jan. 2 ...... | 1 | 0·0180 | 18 | 1 | 0·0180 | 18 | 1 | 0·0261 | 26 |
| Feb. 6 ...... | 2 | ·0060 | 10 | ... | ...... | ... | ... | ...... | ... |
| 16 ...... | 1 | ·0044 | 11 | 1 | ·0048 | 12 | ... | ...... | ... |
| 24 ...... | 3 | ·0131 | 11 | 3 | ·0201 | 17 | 2 | ·0093 | 8 |
| May 6 ...... | 1 | ·0216 | 49 | 1 | ·0226 | 55 | 2 | ·0110 | 26 |
| July 24 ...... | 2 | ·0149 | 11 | 2 | ·0247 | 18 | 1 | ·0140 | 10 |
| 25 ...... | 1 | ·0210 | 35 | 5 | ·0026 | 4 | 1 | ·0329 | 59 |
| **1844.** | | | | | | | | | |
| Mar. 29 ...... | 2 | 0·0314 | 20 | 3 | 0·0309 | 20 | 1 | 0·0448 | 28 |
| 30 ...... | 4 | ·0169 | 14 | 3 | ·0126 | 10 | 2 | ·0161 | 14 |
| Oct. 1 ...... | 1 | ·0156 | 26 | 1 | ·0198 | 33 | 1 | ·0018 | 3 |
| 20 ...... | ... | ...... | ... | 1 | ·0224 | 28 | 1 | ·0904 | 113 |
| Nov. 16 ...... | 2 | ·0200 | 20 | 1 | ·0280 | 28 | 1 | ·0398 | 41 |
| 22 ...... | 1 | ·0248 | 31 | 3 | ·0220 | 28 | 2 | ·0092 | 11 |
| **1845.** | | | | | | | | | |
| Jan. 9 ...... | 1 | 0·0290 | 29 | 1 | 0·0440 | 44 | 1 | 0·0080 | 8 |
| Feb. 24 ...... | 2 | ·0200 | 13 | 3 | ·0185 | 11 | 1 | ·0211 | 13 |
| Mar. 26 ...... | 1 | ·0210 | 15 | 3 | ·0104 | 7 | 1 | ·0070 | 5 |
| Aug. 29 ...... | 3 | ·0053 | 9 | 1 | ·0024 | 4 | 1 | ·0062 | 10 |
| Dec. 3 ...... | 4 | ·0310 | 22 | 1 | ·0667 | 47 | 1 | ·0439 | 31 |
| **1846.** | | | | | | | | | |
| May 12 ...... | 3 | 0·0073 | 7 | 2 | 0·0100 | 10 | 2 | 0·0118 | 12 |
| July 11 ...... | ... | ...... | ... | 2 | ·0118 | 12 | 1 | ·0044 | 13 |
| Aug. 6 ...... | 3 | ·0209 | 18 | 2 | ·0133 | 11 | 2 | ·0147 | 12 |
| 7 ...... | 1 | ·0286 | 13 | 7 | ·0089 | 4 | 3 | ·0123 | 6 |
| 24 ...... | 3 | ·0109 | 8 | 1 | ·0036 | 3 | 1 | ·0160 | 10 |
| 25 ...... | 1 | ·0096 | 6 | 3 | ·0070 | 4 | 1 | ·0071 | 5 |
| 28 ...... | 3 | ·0122 | 14 | 3 | ·0075 | 9 | 1 | ·0114 | 13 |

TABLE IV. (continued).

| Year, Month, and Day. | Westerly Force. | | | Northerly Force. | | | Nadir Force. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Waves. | Absolute Aggregate of Fluctuations. | Absolute Mean of Disturbance. | Number of Waves. | Absolute Aggregate of Fluctuations. | Absolute Mean of Disturbance. | Number of Waves. | Absolute Aggregate of Fluctuations. | Absolute Mean of Disturbance. |
| 1846 (cont[d]). | | | | | | | | | |
| Sept. 4 ...... | 2 | 0·0201 | 13 | 2 | 0·0156 | 10 | 1 | 0·0208 | 13 |
| 5 ...... | 4 | ·0148 | 12 | 3 | ·0226 | 17 | 2 | ·0304 | 23 |
| 10 ...... | 2 | ·0187 | 14 | 3 | ·0047 | 3 | 1 | ·0140 | 10 |
| 11 ...... | 5 | ·0342 | 14 | 5 | ·0226 | 10 | 3 | ·0316 | 13 |
| 21 ...... | 2 | ·0474 | 24 | 3 | ·0201 | 10 | 1 | ·0100 | 5 |
| 22 ...... | 6 | ·0352 | 25 | 3 | ·0425 | 30 | 2 | ·0645 | 46 |
| Oct. 2 ...... | 1 | ·0156 | 26 | 1 | ·0102 | 17 | 1 | ·0060 | 10 |
| 7 ...... | 2 | ·0295 | 17 | 3 | ·0523 | 29 | 1 | ·0378 | 21 |
| 8 ...... | 5 | ·0185 | 15 | 3 | ·0235 | 20 | 1 | ·0905 | 77 |
| Nov. 26 ...... | 2 | ·0237 | 14 | 3 | ·0281 | 19 | 2 | ·0210 | 13 |
| Dec. 23 ...... | 1 | ·0160 | 16 | 1 | ·0170 | 17 | 2 | ·0112 | 11 |
| 1847. | | | | | | | | | |
| Feb. 24 ...... | 2 | 0·0223 | 22 | 1 | 0·0110 | 11 | 1 | 0·0030 | 3 |
| Mar. 1 ...... | 4 | ·0152 | 19 | 2 | ·0167 | 21 | 1 | ·0616 | 77 |
| 19 ...... | 9 | ·0339 | 17 | 2 | ·0960 | 48 | 2 | ·1269 | 70 |
| April 3 ...... | 1 | ·0240 | 30 | 3 | ·0067 | 8 | 1 | ·0264 | 33 |
| 7 ...... | 2 | ·0224 | 14 | 2 | ·0515 | 32 | 2 | ·0205 | 13 |
| 21 ...... | 3 | ·0028 | 5 | 1 | ·0120 | 22 | 1 | ·0156 | 26 |
| May 7 ...... | 1 | ·0344 | 43 | 2 | ·0114 | 14 | 1 | ·0100 | 10 |
| June 24 ...... | 1 | ·0109 | 27 | ... | ...... | ... | ... | ...... | ...... |
| July 9 ...... | ... | ...... | ... | 1 | ·0352 | 88 | 1 | ·0464 | 116 |
| Sept. 24 ...... | 10 | ·0550 | 31 | 5 | ·1912 | 106 | 2 | ·1277 | 75 |
| 26 ...... | 3 | ·0163 | 17 | 1 | ·0401 | 41 | 2 | ·0338 | 34 |
| 27 ...... | 3 | ·0056 | 6 | 1 | ·0300 | 30 | 1 | ·0603 | 62 |
| Oct. 22 ...... | 4 | 0·0043 | 7 | 2 | ·0409 | 71 | 1 | ·0108 | 18 |
| 23*(1st) | 10 | ·0235 | 20 | 3 | ·0564 | 47 | 2 | ·1158 | 100 |
| 23(2nd) | 1 | ·0025 | 13 | 1 | ·0030 | 16 | 1 | ·0016 | 8 |
| 24 ...... | 7 | ·0845 | 36 | 5 | ·2554 | 110 | 7 | ·1144 | 48 |
| 25 ...... | 5 | ·0103 | 10 | 1 | ·0150 | 15 | 1 | ·0654 | 69 |
| Nov. 22 ...... | 6 | ·0226 | 16 | 2 | ·0572 | 41 | 2 | ·1057 | 70 |
| Dec. 17 ...... | 12 | ·0315 | 14 | 2 | ·0552 | 25 | 1 | ·1260 | 90 |
| 18 ...... | 4 | ·0162 | 13 | 1 | ·0193 | 16 | ... | ...... | ...... |
| 19 ...... | 2 | ·0433 | 43 | 1 | ·0910 | 91 | ... | ...... | ...... |
| 20 ...... | 10 | ·0434 | 24 | 6 | ·1277 | 70 | ... | ...... | ...... |
| 1848. | | | | | | | | | |
| Jan. 16 ...... | 2 | 0·0179 | 12 | 1 | 0·0340 | 33 | ... | ...... | ...... |
| 28 ...... | 2 | ·0306 | 22 | 4 | ·0375 | 20 | ... | ...... | ...... |
| Feb. 20 ...... | 6 | ·0380 | 17 | 1 | ·0335 | 37 | ... | ...... | ...... |
| 21 ...... | 4 | ·0267 | 16 | 3 | ·0962 | 42 | ... | ...... | ...... |
| 22 ...... | 2 | ·0045 | 11 | 1 | ·0125 | 31 | ... | ...... | ...... |
| 23 ...... | 2 | ·0235 | 13 | 3 | ·0028 | 3 | ... | ...... | ...... |
| 24 ...... | 3 | ·0375 | 18 | 3 | ·0525 | 23 | ... | ...... | ...... |
| Mar. 17 ...... | 1 | ·0077 | 23 | 2 | ·0093 | 18 | ... | ...... | ...... |
| 20 ...... | 4 | ·0208 | 15 | 1 | ·0309 | 27 | ... | ...... | ...... |
| Apr. 7 ...... | 3 | ·0109 | 10 | 2 | ·0084 | 21 | ... | ...... | ...... |
| May 18 ...... | 4 | ·0096 | 11 | 2 | ·0123 | 14 | ... | ...... | ...... |
| July 11 ...... | 6 | ·0184 | 11 | 2 | ·0689 | 36 | ... | ...... | ...... |
| Oct. 18 ...... | 4 | ·0288 | 25 | 3 | ·0323 | 30 | 1 | 0·0970 | 136 |
| 23 ...... | 4 | ·0200 | 19 | 3 | ·0234 | 24 | ... | ...... | ...... |
| 25 ...... | 3 | ·0158 | 9 | 4 | ·0157 | 9 | ... | ...... | ...... |
| 29 ...... | 2 | ·0129 | 8 | 1 | ·0000 | 0 | ... | ...... | ...... |

* On October 23, 1847, all the observations were interrupted during 10 hours.

TABLE IV. (continued).

| Year, Month, and Day. | Westerly Force. Number of Waves. | Westerly Force. Absolute Aggregate of Fluctuations. | Westerly Force. Absolute Mean of Disturbance. | Northerly Force. Number of Waves. | Northerly Force. Absolute Aggregate of Fluctuations. | Northerly Force. Absolute Mean of Disturbance. | Nadir Force. Number of Waves. | Nadir Force. Absolute Aggregate of Fluctuations. | Nadir Force. Absolute Mean of Disturbance. |
|---|---|---|---|---|---|---|---|---|---|
| 1848 (contd). | | | | | | | | | |
| Nov. 17 ...... | 7 | 0·0683 | 34 | 3 | 0·1961 | 103 | 7 | 0·0769 | 41 |
| 18 ...... | 3 | ·0276 | 19 | 3 | ·0271 | 26 | 1 | ·0208 | 50 |
| Dec. 17 ...... | 2 | ·0161 | 17 | 1 | ·0194 | 35 | 1 | ·0744 | 72 |
| 1849. | | | | | | | | | |
| Oct. 30 ...... | 3 | 0·0209 | 9 | 2 | 0·0228 | 10 | 1 | 0·3484 | 152 |
| Nov. 27 ...... | 3 | ·0295 | 13 | 3 | ·0280 | 12 | ...... | ...... | ...... |
| 1850. | | | | | | | | | |
| Feb. 22 ...... | 4 | 0·0172 | 7 | 4 | 0·0244 | 10 | 1 | 0·2030 | 87 |
| 23 ...... | 6 | ·0186 | 8 | 2 | ·0333 | 14 | 2 | ·0303 | 13 |
| Mar. 31 ...... | 4 | ·0214 | 9 | 1 | ·0375 | 16 | 1 | ·0000 | 0 |
| May 7 ...... | ...... | ...... | ...... | 3 | ·0249 | 10 | ...... | ...... | ...... |
| June 13 ...... | 2 | ·0285 | 12 | 2 | ·0534 | 23 | 1 | ·3882 | 164 |
| Oct. 1 ...... | 1 | ·0487 | 21 | 1 | ·0522 | 23 | 1 | ·1188 | 54 |
| 2 ...... | 3 | ·0421 | 18 | 1 | ·0495 | 21 | 2 | ·0212 | 9 |
| 1851. | | | | | | | | | |
| Jan. 16 ...... | 3 | 0·0432 | 19 | 2 | 0·0517 | 22 | 1 | 0·1009 | 44 |
| 19 ...... | 4 | ·0293 | 12 | 2 | ·0468 | 19 | 1 | ·1367 | 59 |
| Feb. 18 ...... | 5 | ·0252 | 11 | 2 | ·0505 | 22 | 1 | ·1382 | 59 |
| Sept. 3 ...... | 5 | ·0473 | 25 | 3 | ·0522 | 22 | 3 | ·1114 | 48 |
| 4 ...... | 7 | ·0218 | 9 | 5 | ·0444 | 19 | 1 | ·1769 | 77 |
| 6 ...... | 2 | ·0595 | 25 | 3 | ·0378 | 15 | 3 | ·0648 | 28 |
| 7 ...... | 7 | ·0462 | 20 | 7 | ·1108 | 46 | 3 | ·1805 | 76 |
| 29 ...... | 6 | ·0720 | 32 | 3 | ·0972 | 41 | 2 | ·3864 | 172 |
| Oct. 2 ...... | 5 | ·0343 | 14 | 5 | ·0636 | 27 | 3 | ·1370 | 58 |
| 28 ...... | 2 | ·0772 | 33 | 4 | ·0506 | 22 | 1 | ·1834 | 80 |
| Dec. 6 ...... | 4 | ·0465 | 20 | 1 | ·1264 | 54 | 1 | ·0815 | 36 |
| 28 ...... | 5 | ·0247 | 11 | 3 | ·0243 | 10 | 1 | ·0950 | 41 |
| 29 ...... | 4 | ·0420 | 23 | 1 | ·0627 | 28 | 3 | ·0233 | 11 |
| 1852. | | | | | | | | | |
| Jan. 4 ...... | 3 | 0·0357 | 15 | 1 | 0·0968 | 44 | 3 | 0·0523 | 22 |
| 19 ...... | 7 | ·0183 | 8 | 5 | ·0462 | 20 | 1 | ·1206 | 54 |
| Feb. 14 ...... | 4 | ·0217 | 10 | 3 | ·0823 | 37 | 4 | ·0585 | 26 |
| 15 ...... | 7 | ·0412 | 17 | 3 | ·0712 | 30 | 3 | ·1879 | 80 |
| 17 ...... | 6 | ·0283 | 12 | 4 | ·0475 | 20 | 3 | ·2525 | 110 |
| 18 ...... | 7 | ·0277 | 12 | 4 | ·1041 | 43 | 1 | ·4422 | 185 |
| 19 ...... | 3 | ·0919 | 43 | 5 | ·1042 | 44 | 1 | ·2596 | 113 |
| 20 ...... | 7 | ·0186 | 8 | 3 | ·0441 | 18 | 1 | ·1594 | 69 |
| 21 ...... | 3 | ·0370 | 18 | 3 | ·0660 | 28 | 1 | ·1735 | 77 |
| April 20 ...... | 7 | ·0570 | 24 | 3 | ·0796 | 33 | 1 | ·1508 | 67 |
| May 19 ...... | 3 | ·0487 | 30 | 4 | ·0289 | 12 | 1 | ·0595 | 28 |
| 20 ...... | 1 | ·0068 | 10 | 3 | ·0140 | 6 | 1 | ·0605 | 44 |
| June 11 ...... | 3 | ·0514 | 23 | 2 | ·0606 | 26 | 1 | ·4354 | 195 |
| 16 ...... | 4 | ·0310 | 13 | 5 | ·0275 | 12 | ...... | ...... | ...... |
| July 10 ...... | 2 | ·0490 | 23 | 2 | ·0336 | 15 | 3 | ·0660 | 29 |
| Nov. 11 ...... | 3 | ·0393 | 17 | 2 | ·0367 | 16 | 1 | ·3236 | 141 |
| 13 ...... | 3 | ·0386 | 16 | 3 | ·0352 | 15 | 1 | ·1638 | 77 |

TABLE IV. (continued).

| Year, Month, and Day. | Westerly Force. | | | Northerly Force. | | | Nadir Force. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Waves. | Absolute Aggregate of Fluctuations. | Absolute Mean of Disturbance. | Number of Waves. | Absolute Aggregate of Fluctuations. | Absolute Mean of Disturbance. | Number of Waves. | Absolute Aggregate of Fluctuations. | Absolute Mean of Disturbance. |
| 1853. | | | | | | | | | |
| Jan. 10 ...... | 3 | 0·0229 | 10 | 3 | 0·0208 | 9 | ...... | ...... | ...... |
| Mar. 7 ...... | 8 | ·0269 | 11 | 6 | ·0302 | 13 | 1 | 0·3353 | 141 |
| 8 ...... | 6 | ·0293 | 13 | 5 | ·0242 | 10 | 1 | ·5298 | 236 |
| 11 ...... | ...... | ...... | ...... | 5 | ·0279 | 12 | 1 | ·3529 | 152 |
| May 2 ...... | 3 | ·0359 | 16 | 1 | ·0657 | 28 | 1 | ·3595 | 157 |
| 3 ...... | 6 | ·0210 | 9 | 3 | ·0552 | 23 | 1 | ·3424 | 149 |
| 24 ...... | 7 | ·0280 | 12 | 5 | ·0886 | 38 | 3 | ·2273 | 96 |
| June 22 ...... | 3 | ·0253 | 11 | 3 | ·0259 | 11 | 1 | ·1487 | 64 |
| July 12 ...... | 8 | ·0299 | 13 | 3 | ·0646 | 27 | 4 | ·0777 | 33 |
| Aug. 21 ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1 | ·0617 | 26 |
| Sept. 1 ...... | 7 | ·0264 | 11 | 4 | ·0838 | 37 | 2 | ·0648 | 28 |
| 2 ...... | 5 | ·0299 | 13 | 5 | ·0738 | 31 | 2 | ·0717 | 30 |
| Oct. 1 ...... | ...... | ...... | ...... | 1 | ·0312 | 13 | ...... | ...... | ...... |
| 2 ...... | ...... | ...... | ...... | 1 | ·0336 | 14 | ...... | ...... | ...... |
| 25 ...... | 4 | ·0153 | 6 | 3 | ·0160 | 7 | 1 | ·3093 | 129 |
| Nov. 9 ...... | 5 | ·0503 | 21 | 1 | ·0474 | 20 | 2 | ·0766 | 33 |
| Dec. 6 ...... | 5 | ·0354 | 15 | 1 | ·1079 | 45 | 2 | ·0633 | 27 |
| 21 ...... | 5 | ·0176 | 8 | 3 | ·0097 | 42 | 1 | ·1790 | 77 |
| 1854. | | | | | | | | | |
| Jan. 8 ...... | 3 | 0·0249 | 10 | 2 | 0·0374 | 16 | 1 | 0·1089 | 46 |
| 20*...... | 8 | ·0245 | 10 | 3 | ·0108 | 4 | 1 | ·0104 | 15 |
| 20 ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1 | ·0550 | 39 |
| Feb. 16 ...... | 5 | ·0219 | 9 | 5 | ·0383 | 16 | 1 | ·1165 | 49 |
| 24 ...... | 6 | ·0335 | 14 | 4 | ·0230 | 10 | 3 | ·1460 | 62 |
| 25 ...... | 3 | ·0135 | 5 | 6 | ·0235 | 10 | 2 | ·1310 | 55 |
| Mar. 6 ...... | 4 | ·0228 | 10 | 5 | ·0145 | 6 | 1 | ·1049 | 44 |
| 15 ...... | 9 | ·0265 | 11 | 2 | ·0407 | 17 | 4 | ·0514 | 22 |
| 16 ...... | 7 | ·0294 | 12 | 1 | ·0408 | 17 | 1 | ·0498 | 21 |
| 28 ...... | 4 | ·0284 | 12 | 1 | ·1271 | 53 | 1 | ·1451 | 64 |
| April 10 ...... | 6 | ·0458 | 19 | 4 | ·0687 | 29 | 3 | ·0855 | 38 |
| 23 ...... | 3 | ·0233 | 10 | 4 | ·0334 | 14 | 2 | ·0897 | 38 |
| May 25 ...... | 6 | ·0112 | 5 | 3 | ·0188 | 8 | 4 | ·0759 | 32 |
| 1855. | | | | | | | | | |
| Mar. 12 ...... | 5 | 0·0395 | 16 | 2 | 0·0574 | 25 | 1 | 0·2111 | 90 |
| April 4 ...... | 3 | ·0248 | 10 | 7 | ·0154 | 7 | 2 | ·0282 | 14 |
| July 19 ...... | ...... | ...... | ...... | 2 | ·0653 | 29 | 2 | ·0719 | 31 |
| Oct. 18 ...... | 3 | ·0234 | 10 | 2 | ·0499 | 21 | 1 | ·1049 | 44 |
| † | | | | | | | | | |
| 1857. | | | | | | | | | |
| Feb. 26 ...... | 3 | 0·0204 | 9 | 2 | 0·0180 | 8 | 1 | 0·1368 | 59 |
| Mar. 13 ...... | 3 | ·0194 | 8 | ...... | ...... | ...... | ...... | ...... | ...... |
| May 7 ...... | 3 | ·0689 | 29 | 4 | ·0726 | 30 | 1 | ·3191 | 141 |
| 10 ...... | 9 | ·0118 | 5 | 4 | ·0388 | 18 | 2 | ·0893 | 37 |
| Sept. 3 ...... | 6 | ·0372 | 15 | 4 | ·0515 | 21 | 2 | ·4199 | 175 |
| Nov. 12 ...... | 3 | ·0353 | 15 | 4 | ·0162 | 7 | ...... | ...... | ...... |
| 16 ...... | 2 | ·0271 | 12 | 4 | ·0216 | 9 | ...... | ...... | ...... |
| 17 ...... | 3 | ·0605 | 26 | 3 | ·0339 | 15 | ...... | ...... | ...... |
| Dec. 16 ...... | 5 | ·0405 | 17 | 3 | ·0768 | 32 | 1 | ·2230 | 93 |
| 17 ...... | 11 | ·0134 | 6 | 1 | ·0881 | 39 | 2 | ·0543 | 23 |

* 1854, Jan. 20. The Vertical-Force observations were interrupted during 3 hours.

† In 1856 there were no days of Great Magnetic Disturbance throughout the year.

The last figure in the "Absolute Mean of Disturbance" is in the fourth decimal place of Horizontal Force.

TABLE V.—Sums, without regard of sign, of Magnetic Fluctuations (in terms of Horizontal Force) for each Year from 1841 to 1857, including all days of Record of Great Magnetical Disturbance.

| Year. | Number of Storms. | Westerly Force. | | | Northerly Force. | | | Nadir Force. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number of Waves. | Number of Hours. | Absolute Sum of Fluctuations. | Number of Waves. | Number of Hours. | Absolute Sum of Fluctuations. | Number of Waves. | Number of Hours. | Absolute Sum of Fluctuations. |
| 1841 | 8 | 25 | 129·47 | ·3236 | 15 | 119·63 | ·2641 | 12 | 116·19 | ·6143 |
| 1842 | 10 | 19 | 112·57 | ·2699 | 18 | 113·34 | ·4893 | 15 | 111·74 | ·3452 |
| 1843 | 7 | 11 | 55·72 | ·0990 | 13 | 49·39 | ·0928 | 7 | 45·40 | ·0933 |
| 1844 | 6 | 10 | 51·74 | ·1087 | 12 | 59·70 | ·1357 | 8 | 59·29 | ·2021 |
| 1845 | 5 | 11 | 60·00 | ·1063 | 9 | 60·41 | ·1420 | 5 | 60·52 | ·0862 |
| 1846 | 18 | 46 | 244·86 | ·3632 | 50 | 250·89 | ·3213 | 28 | 247·99 | ·4155 |
| 1847 | 21 | 100 | 246·75 | ·5249 | 45 | 246·29 | 1·2229 | 30 | 198·75 | 1·0719 |
| 1848 | 19 | 64 | 264·18 | ·4356 | 43 | 223·83 | ·7128 | 10 | 40·65 | ·2691 |
| 1849 | 2 | 6 | 46·00 | ·0504 | 5 | 45·25 | ·0508 | 1 | 22·92 | ·3484 |
| 1850 | 7 | 20 | 141·79 | ·1765 | 14 | 163·80 | ·2752 | 8 | 138·34 | ·7615 |
| 1851 | 13 | 59 | 294·04 | ·5692 | 41 | 305·70 | ·8190 | 24 | 299·17 | 1·8160 |
| 1852 | 17 | 73 | 364·65 | ·6422 | 55 | 395·76 | ·9785 | 27 | 353·07 | 2·9661 |
| 1853 | 18 | 75 | 327·14 | ·3941 | 53 | 402·06 | ·8065 | 24 | 350·67 | 3·2000 |
| 1854 | 12 | 64 | 285·10 | ·3057 | 40 | 285·82 | ·4770 | 25 | 279·75 | 1·1701 |
| 1855 | 4 | 11 | 71·37 | ·0877 | 13 | 93·75 | ·1880 | 6 | 91·03 | ·4161 |
| 1856 | 0 | 0 | 0·00 | ·0000 | 0 | 0·00 | 0000 | 0 | 0·00 | ·0000 |
| 1857 | 10 | 48 | 231·53 | ·3345 | 29 | 208·37 | ·4175 | 9 | 141·73 | 1·2424 |
| Sums ......... | 177 | 642 | 2926·91 | 4·7915 | 455 | 3023·99 | 7·3934 | 239 | 2557·21 | 15·0182 |
| Means of Absolute Disturbances ... | | | | ·00164 | | | ·00244 | | | ·00587 |

TABLE VI.—Sums, without regard of sign, of Magnetic Fluctuations (in terms of Horizontal Force) for each Year from 1841 to 1857, including only those days of Great Magnetic Disturbance in which Records were made by the three Instruments.

| Year. | Number of Storms. | Westerly Force. | | | Northerly Force. | | | Nadir Force. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number of Waves. | Number of Hours. | Absolute Sum of Fluctuations. | Number of Waves. | Number of Hours. | Absolute Sum of Fluctuations. | Number of Waves. | Number of Hours. | Absolute Sum of Fluctuations. |
| 1841 | 8 | 25 | 129·47 | ·3236 | 15 | 119·63 | ·2641 | 12 | 116·19 | ·6143 |
| 1842 | 10 | 19 | 112·57 | ·2699 | 18 | 113·34 | ·4893 | 15 | 111·74 | ·3452 |
| 1843 | 5 | 8 | 45·72 | ·0886 | 12 | 45·39 | ·0880 | 7 | 45·40 | ·0933 |
| 1844 | 5 | 10 | 51·74 | ·1087 | 11 | 51·70 | ·1133 | 7 | 51·29 | ·1117 |
| 1845 | 5 | 11 | 60·00 | ·1063 | 9 | 60·41 | ·1420 | 5 | 60·52 | ·0862 |
| 1846 | 17 | 46 | 244·86 | ·3632 | 48 | 240·89 | ·3095 | 27 | 244·61 | ·4111 |
| 1847 | 16 | 83 | 202·69 | ·4111 | 36 | 202·19 | ·9497 | 29 | 194·75 | 1·0255 |
| 1848 | 4 | 16 | 55·17 | ·1408 | 10 | 45·74 | ·2749 | 10 | 40·65 | ·2691 |
| 1849 | 1 | 3 | 22·92 | ·0209 | 2 | 22·84 | ·0228 | 1 | 22·92 | ·3484 |
| 1850 | 6 | 20 | 141·79 | ·1765 | 11 | 139·88 | ·2503 | 8 | 138·34 | ·7615 |
| 1851 | 13 | 59 | 294·04 | ·5692 | 41 | 305·70 | ·8190 | 24 | 299·17 | 1·8160 |
| 1852 | 16 | 69 | 341·34 | ·6112 | 50 | 372·27 | ·9510 | 27 | 353·07 | 2·9661 |
| 1853 | 13 | 72 | 304·41 | ·3712 | 43 | 308·40 | ·6930 | 22 | 303·72 | 2·7854 |
| 1854 | 12 | 64 | 285·10 | ·3057 | 40 | 285·82 | ·4770 | 25 | 279·75 | 1·1701 |
| 1855 | 3 | 11 | 71·37 | ·0877 | 11 | 70·97 | ·1227 | 4 | 67·58 | ·3442 |
| 1856 | 0 | 0 | 0·00 | ·0000 | 0 | 0·00 | ·0000 | 0 | 0·00 | ·0000 |
| 1857 | 6 | 37 | 141·04 | ·1922 | 18 | 139·25 | ·3458 | 9 | 141·73 | 1·2424 |
| Sums ......... | 140 | 553 | 2504·23 | 4·1468 | 375 | 2524·42 | 6·3124 | 232 | 2471·43 | 14·3905 |
| Means of Absolute Disturbances ... | | | | ·00166 | | | ·00250 | | | ·00582 |

11. In examining the last line of these Tables, it must be borne in mind that the numbers are affected by the constant part of the Disturbance which appears as "Mean Disturbance" at the end of Table III. The value of mean disturbance for Nadir Force (as has been remarked) is uncertain, and that for Westerly Force is small; but that for Northerly Force is important. A constant term $-\cdot00147$, combined with variable quantities whose mean value is $\pm\cdot00250$, and whose actual value even at the maximum of its wave will very frequently be far less, will destroy some waves entirely. It will also increase the apparent Mean of Absolute Disturbances, even when the number of waves is not diminished. Thus: suppose, as a simple case, that the pure disturbance is represented by $a\sin\theta$, but that, when affected with a constant term, it is $a\sin\theta-b$. (As has been stated, when $a$ is smaller than $b$, the addition of $-b$ will make every value $-$, and will destroy the alternation of $+$ waves and $-$ waves, and thus the just number of waves will be apparently diminished.) When $a$ is greater than $b$, if $\Theta$ be the first value of $\theta$ which makes $a\sin\theta-b=0$, the positive Fluctuation will be found by integrating from $\theta=\Theta$ to $\theta=\pi-\Theta$, and the negative Fluctuation by integrating from $\theta=\pi-\Theta$ to $\theta=2\pi+\Theta$. The general value of the integral is $-a\cos\theta-b\theta$; the first limited integral is $2a\cos\Theta-b(\pi-2\Theta)$: the second is $-2a\cos\Theta-b(\pi+2\Theta)$, or (with sign changed, to make it positive) $+2a\cos\Theta-b(-\pi-2\Theta)$; and the sum of these, or aggregate of absolute fluctuations, is $4a\cos\Theta+4b\,.\,\Theta$. Now $\Theta$ is determined by the condition $a\sin\Theta-b=0$, or $\sin\Theta=\frac{b}{a}\cdot$ If $b$ be small, $\Theta=\frac{b}{a}$ nearly, $\cos\Theta=1-\frac{b^2}{2a^2}$ nearly, and the aggregate of absolute fluctuations $=4a+\frac{2b^2}{a}\cdot$ The second term is the increase of the aggregate arising from the introduction of the term $b$.

If then we conceive the numbers in the last line of Table VI. to be affected with the correction which ought to be introduced in order to neutralize the effect of the large constant term in Northerly Force, it is certain that the number 375 would be considerably increased, and that the number 6·3124 would be considerably diminished. A very extensive examination of details would be necessary to enable us to say what would be the exact proportion of the changes: but it appears to me extremely probable (though at present far from certain) that the corrected Numbers of Waves are sensibly equal, the corrected Absolute Sums of Fluctuations are sensibly equal, and the corrected Means of Absolute Disturbances are sensibly equal, for Westerly Force and for Northerly Force.

The Number of Waves for Nadir Force is less than half that for the other forces; and the Absolute Sum of Fluctuations is about three times as great as that for the others.

12. It would be very important to ascertain any correspondence in the times of the waves in the different directions. I have not yet succeeded in discovering any satisfactory or certain relation.

First, in comparison of the Waves of Westerly and Northerly Forces, the coincidences of times of wave are so rare that it seems evident that nothing can be inferred from the few which can be found. From 1849 to 1857, when the photographic apparatus recorded equally the disturbances at all hours, I do not find one. In a less rigorous examination of the storms from 1841 to 1847, I find that on Nov. 19, 1841, there

were contemporaneous waves from $12^h\ 17^m$ to $13^h\ 17^m$, W. F.+, No. F.+; and on Jan. 1, 1842, when the storm consisted of a single wave, $6^h\ 0^m$ to $12^h\ 41^m$, the forces were W. F.—, No. F.+. And the second W. F.— on Jan. 16, 1848, corresponds nearly with the sole No. F.—. Sometimes two waves in one direction correspond nearly with one in the other direction: thus in the beginning of the storm 1854, April 10, the W. F.+ from $0^h\ 7^m$ to $5^h\ 21^m$ and — from $5^h\ 21^m$ to $13^h\ 16^m$ occupy the same time as No. F.+ from $0^h\ 5^m$ to $13^h\ 9^m$: but this relation is not supported in the remainder of the same storm. A more frequent relation appears to be, that the evanescence of one wave corresponds with the maximum of the other: thus on February 21, 1852, and March 7, 1853, the waves stand in this order:

| | Westerly Force. | | Northerly Force. | |
|---|---|---|---|---|
| | Limits of Waves. | Character of Waves. | Limits of Waves. | Character of Waves. |
| 1852. Feb. 21...... | 0·27 | + | 0·12 | — |
| | 4· 9 | — | 3·14 | + |
| | 15·15 | | 5·16 | — |
| | | | 23·59 | |
| 1853. Mar. 7...... | 0·10 | — | 3·13 | — |
| | 4· 5 | + | 5·32 | + |
| | 6·25 | — | 7·19 | |
| | 12·20 | | | |

which relation, however, in the latter instance, is not maintained through the storm. And, generally, this relation does not appear to hold through the whole of any one storm consisting of numerous waves.

13. As the number of Nadir Waves approximates to half the number of Westerly Waves, it might seem worthy of inquiry whether the maximum of Nadir Wave corresponds to a change of Westerly Wave. The following instances have been remarked.

| Time of Maximum of Nadir Wave. | Sign of Nadir Wave. | Change of Westerly Wave. | Time of Maximum of Nadir Wave. | Sign of Nadir Wave. | Change of Westerly Wave. |
|---|---|---|---|---|---|
| h m | | | h m | | |
| 1841. Sept. 25. 3 35 | + | + to — | 1852. Feb. 18. 4 37 | + | + to — |
| 4 17 | + | — to + | June 11. 14 28 | — | — to + |
| 6 19 | + | + to — | Nov. 11. 8 18 | + | + to — |
| 1847. Sept. 24. 5 51 | + | + to — | 1853. Mar. 8. 6 28 | + | + to — |
| 10 21 | — | — to + | 14 24 | + | + to — |
| Oct. 23. 5 27 | + | + to — | May 2. 17 35 | + | — to + |
| 7 1 | + | + to — | 3. 3 33 | + | + to — |
| Oct. 24. 13 4 | — | — to + | 24. 10 10 | + | — to + |
| Dec. 17. 6 15 | + | — to + | July 12. 11 37 | — | + to — |
| 8 13 | + | — to + | 15 57 | + | — to + |
| 1851. Sept. 4. 7 19 | + | — to + | Sept. 1. 15 37 | — | + to — |
| 7. 4 14 | + | + to — | 2. 5 18 | + | + to — |
| 6 30 | + | — to + | Oct. 25. 13 47 | + | + to — |
| 7 34 | — | + to — | 1854. Apr. 10. 17 56 | — | — to + |
| 10 19 | — | + to — | 1857. Dec. 17. 6 10 | + | + to — |
| 1852. Feb. 18. 2 56 | + | + to — | | | |

I am unable to draw any inference from these.

14. The classification in Article 9 appears to lead to no result as to the effect of connexion of special signs of the first or last waves of the different forces. The inequalities shown in the first Table of Article 9 (of which the difference of numbers of last wave + and numbers of last wave — for the Northerly Force is the most remarkable) are quite sufficient to explain the inequalities in the combinations exhibited in the latter part of Article 9. And, on the whole, the principal conclusions which can be deduced from the examination of the Waves appear to me to be the following:—

That, while on the whole the Westerly Force is —, yet the number of + waves is the greater; and at the beginnings and ends of storms the number of + waves is greater than the number of — waves in a proportion exceeding 3 : 2.

That, the Northerly Force being on the whole —, in two instances out of three the first Northerly wave is —, and in ten instances out of eleven the last Northerly wave is —.

That, due regard being had to the effect of the constant — Northerly Force, it appears probable that the number of waves and the mean value of wave-disturbance are nearly the same for Westerly Force and for Northerly Force; but

That for the Nadir Force the number of waves is less than one-half the number for the other forces, while the mean value of disturbance is more than double that for the other forces.

15. I now proceed with the Irregularities. The following Tables (VII., VIII., IX.) exhibit their aggregates under the same divisions as those for the Waves. It will be remarked that, from the nature of the process by which the Irregularities are found, their algebraic sum in each storm is sensibly $=0$; and therefore they are treated here only as numbers without sign.

TABLE VII.—Absolute Sums, without regard of sign, of Coefficients of Magnetic Irregularity (in terms of Horizontal Force), on Days of Great Magnetic Disturbance.

| Year, Month, and Day. | Westerly Force. | | | Northerly Force. | | | Nadir Force. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Irregularities. | Absolute Sum of Coefficients of Irregularity. | Mean Coefficient of Irregularity. | Number of Irregularities. | Absolute Sum of Coefficients of Irregularity. | Mean Coefficient of Irregularity. | Number of Irregularities. | Absolute Sum of Coefficients of Irregularity. | Mean Coefficient of Irregularity. |
| 1841. | | | | | | | | | |
| Sept. 24 ...... | 10 | 0·0133 | 13 | 6 | 0·0060 | 10 | 2 | 0·0031 | 15 |
| 25 ...... | 70 | ·1417 | 20 | 73 | ·1226 | 17 | 61 | ·1760 | 29 |
| 27 ...... | 6 | ·0086 | 14 | 12 | ·0090 | 8 | 3 | ·0021 | 7 |
| Oct. 25 ...... | 33 | ·0437 | 13 | 36 | ·0354 | 10 | 14 | ·0157 | 11 |
| Nov. 18 ...... | 25 | ·0329 | 13 | 28 | ·0325 | 12 | 18 | ·0208 | 12 |
| 19 ...... | 19 | ·0252 | 13 | 26 | ·0213 | 8 | 13 | ·0139 | 11 |
| Dec. 3 ...... | 7 | ·0134 | 19 | 13 | ·0127 | 10 | 3 | ·0018 | 6 |
| 14 ...... | 8 | ·0145 | 18 | 9 | ·0146 | 16 | 6 | ·0072 | 12 |
| 1842. | | | | | | | | | |
| Jan. 1 ...... | 6 | 0·0068 | 11 | 8 | 0·0038 | 5 | 5 | 0·0021 | 4 |
| Feb. 24 ...... | 7 | ·0132 | 19 | 9 | ·0162 | 18 | 3 | ·0013 | 4 |
| April 14 ...... | 12 | ·0152 | 13 | 11 | ·0168 | 15 | 6 | ·0090 | 15 |
| 15 ...... | 20 | ·0291 | 15 | 35 | ·0373 | 11 | 15 | ·0134 | 9 |
| July 1 ...... | 9 | ·0137 | 15 | 15 | ·0198 | 13 | 10 | ·0113 | 11 |
| 2 ...... | 23 | ·0349 | 15 | 35 | ·0502 | 14 | 10 | ·0134 | 13 |
| 3 ...... | 29 | ·0437 | 15 | 42 | ·0502 | 12 | 20 | ·0236 | 12 |
| Nov. 10 ...... | 11 | ·0197 | 18 | 14 | ·0139 | 10 | 4 | ·0021 | 5 |
| 21 ...... | 14 | ·0132 | 9 | 15 | ·0204 | 14 | 1 | ·0008 | 8 |
| Dec. 9 ...... | 19 | ·0209 | 11 | 36 | ·0176 | 5 | 6 | ·0036 | 6 |
| 1843. | | | | | | | | | |
| Jan. 2 ...... | 5 | 0·0059 | 12 | 6 | 0·0056 | 9 | 2 | 0·0005 | 3 |
| Feb. 6 ...... | 3 | ·0024 | 8 | ... | ...... | ... | ... | ...... | ... |
| 16 ...... | 7 | ·0008 | 1 | 6 | ·0015 | 3 | ... | ...... | ... |
| 24 ...... | 12 | ·0118 | 10 | 37 | ·0166 | 4 | 6 | ·0041 | 7 |
| May 6 ...... | 17 | ·0206 | 12 | 22 | ·0196 | 9 | 9 | ·0105 | 12 |
| July 24 ...... | 4 | ·0047 | 12 | 6 | ·0058 | 10 | 5 | ·0013 | 3 |
| 25 ...... | 14 | ·0151 | 11 | 13 | ·0141 | 11 | 5 | ·0015 | 3 |
| 1844. | | | | | | | | | |
| Mar. 29 ...... | 21 | 0·0230 | 11 | 24 | 0·0159 | 7 | 9 | 0·0046 | 5 |
| 30 ...... | 18 | ·0246 | 14 | 29 | ·0335 | 12 | 7 | ·0041 | 6 |
| Oct. 1 ...... | 9 | ·0056 | 6 | 9 | ·0070 | 8 | 1 | ·0005 | 5 |
| 20 ...... | ... | ...... | ... | 11 | ·0113 | 10 | 3 | ·0046 | 15 |
| Nov. 16 ...... | 28 | ·0290 | 10 | 19 | ·0190 | 10 | 9 | ·0049 | 5 |
| 22 ...... | 22 | ·0234 | 11 | 31 | ·0300 | 10 | 9 | ·0072 | 8 |
| 1845. | | | | | | | | | |
| Jan. 9 ...... | 15 | 0·0167 | 11 | 9 | 0·0105 | 12 | 4 | 0·0033 | 8 |
| Feb. 24 ...... | 16 | ·0163 | 10 | 26 | ·0123 | 5 | 13 | ·0072 | 6 |
| Mar. 26 ...... | 12 | ·0125 | 10 | 16 | ·0124 | 8 | 4 | ·0028 | 7 |
| Aug. 29 ...... | 19 | ·0065 | 3 | 11 | ·0087 | 8 | 5 | ·0015 | 3 |
| Dec. 3 ...... | 57 | ·0698 | 12 | 61 | ·0708 | 12 | 27 | ·0242 | 9 |
| 1846. | | | | | | | | | |
| May 12 ...... | 13 | 0·0161 | 12 | 15 | 0·0130 | 9 | 4 | 0·0044 | 11 |
| July 11 ...... | ... | ...... | ... | 14 | ·0178 | 13 | 7 | ·0057 | 8 |
| Aug. 6 ...... | 26 | ·0172 | 7 | 35 | ·0172 | 5 | 7 | ·0036 | 5 |
| 7 ...... | 64 | ·0207 | 3 | 55 | ·0308 | 6 | 15 | ·0090 | 6 |
| 24 ...... | 9 | ·0075 | 8 | 9 | ·0055 | 6 | 5 | ·0015 | 3 |
| 25 ...... | 5 | ·0033 | 7 | 5 | ·0059 | 12 | 2 | ·0015 | 8 |
| 28 ...... | 28 | ·0150 | 5 | 24 | ·0178 | 7 | 3 | ·0023 | 8 |

TABLE VII. (continued).

| Year, Month, and Day. | Westerly Force. Number of Irregularities. | Westerly Force. Absolute Sum of Coefficients of Irregularity. | Westerly Force. Mean Coefficient of Irregularity. | Northerly Force. Number of Irregularities. | Northerly Force. Absolute Sum of Coefficients of Irregularity. | Northerly Force. Mean Coefficient of Irregularity. | Nadir Force. Number of Irregularities. | Nadir Force. Absolute Sum of Coefficients of Irregularity. | Nadir Force. Mean Coefficient of Irregularity. |
|---|---|---|---|---|---|---|---|---|---|
| 1846 (cont[d]). | | | | | | | | | |
| Sept. 4 ...... | 26 | 0·0178 | 7 | 29 | 0·0156 | 5 | 5 | 0·0028 | 6 |
| 5 ...... | 32 | ·0255 | 8 | 36 | ·0285 | 8 | 7 | ·0093 | 13 |
| 10 ...... | 6 | ·0049 | 8 | 6 | ·0056 | 9 | 3 | ·0008 | 3 |
| 11 ...... | 28 | ·0311 | 11 | 31 | ·0378 | 12 | 12 | ·0123 | 10 |
| 21 ...... | 23 | ·0162 | 7 | 18 | ·0158 | 9 | 7 | ·0041 | 6 |
| 22 ...... | 68 | ·0771 | 11 | 59 | ·0692 | 12 | 28 | ·0244 | 9 |
| Oct. 2 ...... | 8 | ·0089 | 11 | 11 | ·0100 | 9 | 3 | ·0018 | 6 |
| 7 ...... | 25 | ·0343 | 14 | 28 | ·0295 | 11 | 3 | ·0049 | 16 |
| 8 ...... | 29 | ·0213 | 8 | 29 | ·0245 | 9 | 5 | ·0031 | 6 |
| Nov. 26 ...... | 28 | ·0253 | 9 | 29 | ·0235 | 9 | 7 | ·0080 | 11 |
| Dec. 23 ...... | 12 | ·0163 | 14 | 9 | ·0133 | 17 | 7 | ·0039 | 6 |
| 1847. | | | | | | | | | |
| Feb. 24 ...... | 20 | 0·0132 | 7 | 15 | 0·0107 | 7 | 4 | 0·0026 | 7 |
| Mar. 1 ...... | 42 | ·0416 | 10 | 43 | ·0384 | 9 | 16 | ·0126 | 8 |
| 19 ...... | 49 | ·0835 | 17 | 36 | ·0518 | 14 | 24 | ·0283 | 12 |
| April 3 ...... | 15 | ·0214 | 14 | 18 | ·0232 | 13 | 3 | ·0039 | 13 |
| 7 ...... | 19 | ·0225 | 12 | 22 | ·0306 | 14 | 4 | ·0044 | 11 |
| 21 ...... | 12 | ·0142 | 12 | 8 | ·0095 | 12 | 2 | ·0018 | 9 |
| May 7 ...... | 6 | ·0088 | 15 | 4 | ·0047 | 12 | 2 | ·0010 | 5 |
| June 24 ...... | 3 | ·0046 | 15 | ... | ...... | ... | ... | ...... | ... |
| July 9 ...... | ... | ...... | ... | 8 | ·0134 | 17 | 5 | ·0075 | 15 |
| Sept. 24 ...... | 148 | ·2666 | 18 | 128 | ·3262 | 26 | 119 | ·2192 | 18 |
| 26 ...... | 12 | ·0128 | 11 | 15 | ·0142 | 9 | 9 | ·0087 | 10 |
| 27 ...... | 16 | ·0167 | 10 | 12 | ·0124 | 10 | 10 | ·0201 | 20 |
| Oct. 22 ...... | 29 | ·0232 | 8 | 30 | ·0406 | 14 | 24 | ·0157 | 6 |
| 23*(1st) | 86 | ·1132 | 13 | 73 | ·1332 | 18 | 58 | ·0882 | 15 |
| 23(2nd) | 3 | ·0016 | 5 | 1 | ·0021 | 21 | 2 | ·0088 | 44 |
| 24 ...... | 113 | ·2034 | 18 | 128 | ·3134 | 24 | 94 | ·1722 | 18 |
| 25 ...... | 20 | ·0225 | 11 | 17 | ·0184 | 11 | 7 | ·0121 | 17 |
| Nov. 22 ...... | 34 | ·0428 | 13 | 46 | ·0462 | 10 | 15 | ·0375 | 25 |
| Dec. 17 ...... | 86 | ·1400 | 16 | 39 | ·0577 | 15 | 33 | ·0540 | 16 |
| 18 ...... | 29 | ·0297 | 10 | 21 | ·0236 | 11 | ... | ...... | ... |
| 19 ...... | 66 | ·0937 | 14 | 44 | ·0963 | 22 | ... | ...... | ... |
| 20 ...... | 97 | ·2546 | 26 | 64 | ·2191 | 34 | ... | ...... | ... |
| 1848. | | | | | | | | | |
| Jan. 16 ...... | 21 | 0·0570 | 27 | 21 | 0·0381 | 18 | ... | ...... | ... |
| 28 ...... | 18 | ·0361 | 20 | 19 | ·0422 | 22 | ... | ...... | ... |
| Feb. 20 ...... | 35 | ·0573 | 16 | 16 | ·0329 | 21 | ... | ...... | ... |
| 21 ...... | 35 | ·1182 | 34 | 49 | ·1857 | 38 | ... | ...... | ... |
| 22 ...... | 4 | ·0099 | 25 | 5 | ·0087 | 17 | ... | ...... | ... |
| 23 ...... | 16 | ·0283 | 18 | 12 | ·0248 | 21 | ... | ...... | ... |
| 24 ...... | 24 | ·0431 | 18 | 21 | ·0407 | 19 | ... | ...... | ... |
| Mar. 17 ...... | 4 | ·0036 | 9 | 7 | ·0141 | 20 | ... | ...... | ... |
| 20 ...... | 28 | ·0553 | 20 | 20 | ·0470 | 23 | ... | ...... | ... |
| April 7 ...... | 21 | ·0390 | 19 | 9 | ·0241 | 27 | ... | ...... | ... |
| May 18 ...... | 20 | ·0233 | 12 | 12 | ·0252 | 21 | ... | ...... | ... |
| July 11 ...... | 33 | ·0544 | 16 | 25 | ·0608 | 24 | ... | ...... | ... |
| Oct. 18 ...... | 21 | ·0675 | 32 | 18 | ·0666 | 37 | 14 | 0·0524 | 37 |
| 23 ...... | 23 | ·0518 | 23 | 19 | ·0396 | 21 | ... | ...... | ... |
| 25 ...... | 20 | ·0284 | 14 | 22 | ·0300 | 14 | ... | ...... | ... |
| 29 ...... | 11 | ·0185 | 17 | 1 | ·0018 | 18 | ... | ...... | ... |

* On Oct. 23, 1847, all the observations were interrupted during 10 hours.

TABLE VII. (continued).

| Year, Month, and Day. | Westerly Force. | | | Northerly Force. | | | Nadir Force. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Irregularities. | Absolute Sum of Coefficients of Irregularity. | Mean Coefficient of Irregularity. | Number of Irregularities. | Absolute Sum of Coefficients of Irregularity. | Mean Coefficient of Irregularity. | Number of Irregularities. | Absolute Sum of Coefficients of Irregularity. | Mean Coefficient of Irregularity. |
| 1848 (cont[d]). | | | | | | | | | |
| Nov. 17 ...... | 38 | 0·1225 | 32 | 77 | 0·2394 | 31 | 41 | 0·2362 | 58 |
| 18 ...... | 17 | ·0272 | 16 | 17 | ·0306 | 18 | 1 | ·0008 | 8 |
| Dec. 17 ...... | 19 | ·0396 | 21 | 12 | ·0213 | 18 | 14 | ·0167 | 12 |
| 1849. | | | | | | | | | |
| Oct. 30 ...... | 19 | 0·0232 | ... | 8 | 0·0192 | ... | 4 | 0·0046 | 12 |
| Nov. 27 ...... | 11 | ·0158 | ... | 7 | ·0166 | ... | ... | ...... | ... |
| 1850. | | | | | | | | | |
| Feb. 22 ...... | 27 | 0·0219 | 8 | 26 | 0·0356 | 14 | 5 | 0·0113 | 23 |
| 23 ...... | 35 | ·0506 | 15 | 28 | ·0612 | 22 | 3 | ·0129 | 43 |
| Mar. 31 ...... | 29 | ·0249 | 9 | 17 | ·0249 | 15 | 1 | ·0072 | 72 |
| May 7 ...... | ... | ...... | ... | 13 | ·0174 | 13 | ... | ...... | ... |
| June 13 ...... | 13 | ·0180 | 14 | 14 | ·0202 | 14 | 4 | ·0123 | 31 |
| Oct. 1 ...... | 34 | ·0384 | 11 | 30 | ·0405 | 14 | 8 | ·0123 | 15 |
| 2 ...... | 25 | ·0390 | 16 | 25 | ·0400 | 16 | 7 | ·0087 | 12 |
| 1851. | | | | | | | | | |
| Jan. 16 ...... | 43 | 0·0544 | 13 | 36 | 0·0429 | 12 | 4 | 0·0090 | 23 |
| 19 ...... | 37 | ·0341 | 9 | 35 | ·0420 | 12 | 6 | ·0077 | 13 |
| Feb. 18 ...... | 22 | ·0297 | 13 | 39 | ·0410 | 11 | 20 | ·0165 | 8 |
| Sept. 3 ...... | 19 | ·0311 | 16 | 28 | ·0231 | 8 | 40 | ·0355 | 9 |
| 4 ...... | 29 | ·0512 | 18 | 63 | ·0843 | 13 | 42 | ·0460 | 11 |
| 6 ...... | 18 | ·0320 | 18 | 40 | ·0558 | 14 | 47 | ·0388 | 8 |
| 7 ...... | 89 | ·1659 | 19 | 106 | ·1899 | 18 | 86 | ·1367 | 16 |
| 29 ...... | 63 | ·1426 | 23 | 122 | ·1828 | 15 | 67 | ·1115 | 17 |
| Oct. 2 ...... | 33 | ·0489 | 15 | 43 | ·0602 | 14 | 29 | ·0414 | 14 |
| 28 ...... | 24 | ·0448 | 19 | 46 | ·0509 | 11 | 20 | ·0180 | 9 |
| Dec. 6 ...... | 40 | ·0697 | 17 | 51 | ·0615 | 12 | 30 | ·0404 | 13 |
| 28 ...... | 36 | ·0381 | 11 | 37 | ·0313 | 9 | 15 | ·0144 | 10 |
| 29 ...... | 47 | ·0463 | 10 | 52 | ·0452 | 9 | 12 | ·0098 | 8 |
| 1852. | | | | | | | | | |
| Jan. 4 ...... | 38 | 0·0343 | 9 | 22 | 0·0208 | 9 | 18 | 0·0087 | 5 |
| 19 ...... | 31 | ·0358 | 12 | 59 | ·0540 | 9 | 31 | ·0177 | 6 |
| Feb. 14 ...... | 20 | ·0255 | 13 | 19 | ·0562 | 30 | 17 | ·0195 | 11 |
| 15 ...... | 101 | ·0987 | 10 | 62 | ·0888 | 14 | 53 | ·0398 | 7 |
| 17 ...... | 90 | ·1440 | 16 | 92 | ·1924 | 21 | 124 | ·1354 | 11 |
| 18 ...... | 73 | ·0965 | 13 | 66 | ·1295 | 20 | 54 | ·0576 | 11 |
| 19 ...... | 73 | ·1630 | 22 | 71 | ·1397 | 20 | 100 | ·1789 | 18 |
| 20 ...... | 45 | ·0457 | 10 | 60 | ·0641 | 11 | 17 | ·0198 | 12 |
| 21 ...... | 50 | ·0739 | 15 | 70 | ·0785 | 11 | 23 | ·0226 | 10 |
| April 20 ...... | 52 | ·0690 | 13 | 52 | ·1515 | 29 | 41 | ·0440 | 11 |
| May 19 ...... | 25 | ·0207 | 8 | 36 | ·0322 | 9 | 12 | ·0121 | 10 |
| 20 ...... | 3 | ·0031 | 10 | 37 | ·0466 | 13 | 14 | ·0077 | 6 |
| June 11 ...... | 31 | ·0573 | 18 | 37 | ·0586 | 16 | 32 | ·0352 | 11 |
| 16 ...... | 41 | ·0373 | 9 | 39 | ·0464 | 12 | ... | ...... | ... |
| July 10 ...... | 29 | ·0352 | 12 | 25 | ·0411 | 16 | 15 | ·0111 | 7 |
| Nov. 11 ...... | 37 | ·0483 | 13 | 38 | ·0435 | 11 | 20 | ·0224 | 11 |
| 13 ...... | 43 | ·0506 | 12 | 25 | ·0301 | 12 | 12 | ·0080 | 7 |
| 1853. | | | | | | | | | |
| Jan. 10 ...... | 19 | 0·0195 | 10 | 16 | 0·0146 | 9 | ... | ...... | ... |
| Mar. 7 ...... | 66 | ·0423 | 6 | 63 | ·0423 | 7 | 11 | 0·0201 | 18 |
| 8 ...... | 72 | ·0621 | 9 | 57 | ·0415 | 7 | 11 | ·0147 | 13 |

## Table VII. (concluded).

| Year, Month, and Day. | Westerly Force. | | | Northerly Force. | | | Nadir Force. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Irregu-larities. | Absolute Sum of Coeffi-cients of Irregularity. | Mean Coefficient of Irregu-larity. | Number of Irregu-larities. | Absolute Sum of Coeffi-cients of Irregularity. | Mean Coefficient of Irregu-larity. | Number of Irregu-larities. | Absolute Sum of Coeffi-cients of Irregularity. | Mean Coefficient of Irregu-larity. |
| 1853 (contd). | | | | | | | | | |
| Mar. 11 ...... | ...... | ......... | ...... | 54 | 0·0411 | 8 | 11 | 0·0175 | 16 |
| May 2 ...... | 59 | 0·0367 | 6 | 80 | ·0528 | 7 | 15 | ·0165 | 11 |
| 3 ...... | 63 | ·0391 | 6 | 61 | ·0556 | 9 | 21 | ·0157 | 7 |
| 24 ...... | 77 | ·0646 | 8 | 97 | ·1206 | 12 | 37 | ·0555 | 15 |
| June 22 ...... | 50 | ·0361 | 7 | 51 | ·0454 | 9 | 17 | ·0170 | 10 |
| July 12 ...... | 123 | ·1097 | 9 | 129 | ·1231 | 10 | 34 | ·0524 | 15 |
| Aug. 21 ...... | ...... | ......... | ...... | ...... | ......... | ...... | 8 | ·0118 | 15 |
| Sept. 1 ...... | 42 | ·0260 | 6 | 46 | ·0418 | 9 | 13 | ·0190 | 15 |
| 2 ...... | 70 | ·0665 | 9 | 90 | ·0959 | 11 | 36 | ·0391 | 11 |
| Oct. 1 ...... | ...... | ......... | ...... | 12 | ·0036 | 3 | ...... | ......... | ...... |
| 2 ...... | ...... | ......... | ...... | 9 | ·0037 | 4 | ...... | ......... | ...... |
| 25 ...... | 22 | ·0187 | 9 | 27 | ·0156 | 6 | 10 | ·0105 | 10 |
| Nov. 9 ...... | 49 | ·0407 | 9 | 49 | ·0376 | 8 | 19 | ·0118 | 6 |
| Dec. 6 ...... | 60 | ·0489 | 8 | 41 | ·0461 | 11 | 26 | ·0321 | 12 |
| 21 ...... | 35 | ·0298 | 8 | 28 | ·0221 | 8 | 8 | ·0067 | 8 |
| 1854. | | | | | | | | | |
| Jan. 8 ...... | 33 | 0·0207 | 6 | 24 | 0·0218 | 9 | 13 | 0·0090 | 7 |
| 20*...... | 49 | ·0279 | 6 | 35 | ·0206 | 6 | 4 | ·0023 | 6 |
| 20 ...... | ...... | ......... | ...... | ...... | ......... | ...... | 4 | ·0059 | 15 |
| Feb. 16 ...... | 56 | ·0460 | 8 | 67 | ·0527 | 8 | 26 | ·0170 | 7 |
| 24 ...... | 53 | ·0460 | 9 | 67 | ·0481 | 7 | 21 | ·0175 | 8 |
| 25 ...... | 56 | ·0405 | 7 | 63 | ·0487 | 8 | 22 | ·0208 | 9 |
| Mar. 6 ...... | 33 | ·0178 | 5 | 37 | ·0204 | 6 | 16 | ·0216 | 14 |
| 15 ...... | 59 | ·0463 | 8 | 65 | ·0425 | 7 | 28 | ·0229 | 8 |
| 16 ...... | 58 | ·0556 | 10 | 69 | ·0513 | 7 | 24 | ·0188 | 8 |
| 28 ...... | 62 | ·0591 | 9 | 77 | ·0549 | 7 | 49 | ·0249 | 5 |
| April 10 ...... | 49 | ·0527 | 11 | 79 | ·0688 | 9 | 52 | ·0357 | 7 |
| 23 ...... | 38 | ·0206 | 6 | 49 | ·0322 | 7 | 21 | ·0108 | 5 |
| May 25 ...... | 38 | ·0229 | 6 | 52 | ·0342 | 6 | 32 | ·0301 | 9 |
| 1855. | | | | | | | | | |
| Mar. 12 ...... | 55 | 0·0361 | 6 | 59 | 0·0320 | 5 | 23 | 0·0157 | 7 |
| April 4 ...... | 55 | ·0355 | 6 | 53 | ·0390 | 7 | 19 | ·0111 | 6 |
| July 19 ...... | ...... | ......... | ...... | 80 | ·0451 | 6 | 21 | ·0152 | 7 |
| Oct. 18 ...... | 40 | ·0267 | 7 | 60 | ·0311 | 5 | 13 | ·0111 | 8 |
| † | | | | | | | | | |
| 1857. | | | | | | | | | |
| Feb. 26 ...... | 41 | 0·0128 | 3 | 21 | 0·0119 | 6 | 10 | 0·0126 | 13 |
| Mar. 13 ...... | 37 | ·0155 | 4 | ...... | ......... | ...... | ...... | ......... | ...... |
| May 7 ...... | 90 | ·0778 | 9 | 102 | ·0883 | 9 | 58 | ·0504 | 9 |
| 10 ...... | 60 | ·0196 | 3 | 65 | ·0309 | 5 | 13 | ·0129 | 10 |
| Sept. 3 ...... | 55 | ·0501 | 9 | 92 | ·0629 | 7 | 37 | ·0296 | 8 |
| Nov. 12 ...... | 47 | ·0256 | 5 | 58 | ·0292 | 5 | ...... | ......... | ...... |
| 16 ...... | 41 | ·0265 | 6 | 56 | ·0191 | 3 | ...... | ......... | ...... |
| 17 ...... | 42 | ·0329 | 8 | 68 | ·0307 | 4 | ...... | ......... | ...... |
| Dec. 16 ...... | 66 | ·0847 | 13 | 82 | ·1496 | 18 | 19 | ·0147 | 8 |
| 17 ...... | 78 | ·0626 | 8 | 93 | ·0771 | 8 | 30 | ·0221 | 7 |

In the column "Mean Coefficient of Irregularity," the last figures correspond to the fourth decimal place of Horizontal Force.

* In 1854, Jan. 20, the Vertical Force observations were interrupted during 3 hours.

† In 1856 there were no days of Great Magnetic Disturbance throughout the year.

TABLE VIII.—Sums, without regard of sign, of Coefficients of Magnetic Irregularity (in terms of Horizontal Force), for each Year from 1841 to 1857, including all days of Record of Great Magnetical Disturbance.

| Year. | Westerly Force. | | | Northerly Force. | | | Nadir Force. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Storms. | Number of Irregularities. | Sum of Coefficients. | Number of Storms. | Number of Irregularities. | Sum of Coefficients. | Number of Storms. | Number of Irregularities. | Sum of Coefficients. |
| 1841 | 8 | 178 | ·2933 | 8 | 203 | ·2541 | 8 | 120 | ·2406 |
| 1842 | 10 | 150 | ·2104 | 10 | 220 | ·2462 | 10 | 80 | ·0806 |
| 1843 | 7 | 62 | ·0613 | 6 | 90 | ·0632 | 5 | 27 | ·0179 |
| 1844 | 5 | 98 | ·1056 | 6 | 123 | ·1167 | 6 | 38 | ·0259 |
| 1845 | 5 | 119 | ·1218 | 5 | 123 | ·1147 | 5 | 53 | ·0390 |
| 1846 | 17 | 430 | ·3585 | 18 | 442 | ·3813 | 18 | 130 | ·1034 |
| 1847 | 20 | 905 | 1·4306 | 20 | 772 | 1·4857 | 17 | 431 | ·6986 |
| 1848 | 19 | 408 | ·8810 | 19 | 382 | ·9736 | 4 | 70 | ·3061 |
| 1849 | 2 | 30 | ·0390 | 2 | 15 | ·0358 | 1 | 4 | ·0046 |
| 1850 | 6 | 163 | ·1928 | 7 | 153 | ·2398 | 6 | 28 | ·0647 |
| 1851 | 13 | 500 | ·7888 | 13 | 698 | ·9109 | 13 | 418 | ·5257 |
| 1852 | 17 | 782 | 1·0389 | 17 | 810 | 1·2740 | 16 | 583 | ·6405 |
| 1853 | 14 | 807 | ·6407 | 17 | 910 | ·8034 | 15 | 277 | ·3404 |
| 1854 | 12 | 584 | ·4561 | 12 | 684 | ·4962 | 12 | 312 | ·2373 |
| 1855 | 3 | 150 | ·0983 | 4 | 252 | ·1472 | 4 | 76 | ·0531 |
| 1856 | 0 | 0 | ·0000 | 0 | 0 | ·0000 | 0 | 0 | ·0000 |
| 1857 | 10 | 557 | ·4081 | 9 | 637 | ·4997 | 6 | 167 | ·1423 |
| Sums ......... | 168 | 5923 | 7·1252 | 173 | 6514 | 8·0425 | 146 | 2814 | 3·5207 |
| Mean Coefficient ... | | | ·00120 | | | ·00123 | | | ·00125 |

TABLE IX.—Sums, without regard of sign, of Coefficients of Magnetic Irregularity (in terms of Horizontal Force), for each Year from 1841 to 1857, including only those days of Great Magnetic Disturbance in which Records were made by the three Instruments.

| Year. | Number of Storms. | Westerly Force. | | Northerly Force. | | Nadir Force. | |
|---|---|---|---|---|---|---|---|
| | | Number of Irregularities. | Sum of Coefficients. | Number of Irregularities. | Sum of Coefficients. | Number of Irregularities. | Sum of Coefficients. |
| 1841 | 8 | 178 | ·2933 | 203 | ·2541 | 120 | ·2406 |
| 1842 | 10 | 150 | ·2104 | 220 | ·2462 | 80 | ·0806 |
| 1843 | 5 | 52 | ·0581 | 84 | ·0617 | 27 | ·0179 |
| 1844 | 5 | 98 | ·1056 | 112 | ·1054 | 35 | ·0213 |
| 1845 | 5 | 119 | ·1218 | 123 | ·1147 | 53 | ·0390 |
| 1846 | 17 | 430 | ·3585 | 428 | ·3635 | 123 | ·0977 |
| 1847 | 16 | 710 | 1·0480 | 635 | 1·1333 | 426 | ·6911 |
| 1848 | 4 | 95 | ·2568 | 124 | ·3579 | 70 | ·3061 |
| 1849 | 1 | 19 | ·0232 | 8 | ·0192 | 4 | ·0046 |
| 1850 | 6 | 163 | ·1928 | 140 | ·2224 | 28 | ·0647 |
| 1851 | 13 | 500 | ·7888 | 698 | ·9109 | 418 | ·5257 |
| 1852 | 16 | 741 | 1·0016 | 771 | 1·2276 | 583 | ·6405 |
| 1853 | 13 | 788 | ·6212 | 819 | ·7404 | 258 | ·3111 |
| 1854 | 12 | 584 | ·4561 | 684 | ·4962 | 312 | ·2373 |
| 1855 | 3 | 150 | ·0983 | 172 | ·1021 | 55 | ·0379 |
| 1856 | 0 | 0 | ·0000 | 0 | ·0000 | 0 | ·0000 |
| 1857 | 6 | 390 | ·3076 | 455 | ·4207 | 167 | ·1423 |
| Sums ... | 140 | 5167 | 5·9421 | 5676 | 6·7763 | 2759 | 3·4584 |
| Mean Coefficient... | | | ·00115 | | ·00119 | | ·00125 |

16. The most striking particulars in the last line of these Tables are the following: First, the almost exact equality of the Mean Coefficients of Irregularity in the three

elements. And this remarkable agreement proves that the Irregularities as measured here are real objective facts. For they are measured from photographic sheets in which the scales are very different: on the Westerly and Northerly records, 0·01 of Horizontal Force is represented by 2·87 inches and 2·55 inches, while on the Nadir record 0·01 of Horizontal Force is represented by 0·88 inch. Yet the eye of the Reader of the Photographs has caught the Irregularities when shown on this small scale as certainly as when shown on the larger scale. With reference to their physical import, I think it likely that the equality of Coefficients of Irregularity may hereafter prove to be one of the most important of the facts of observation.

Second, the near agreement in the number of Irregularities for Westerly Force and for Northerly Force.

Third, the near agreement in the number of Irregularities for Nadir Force with half the number of Irregularities for Westerly or for Northerly Force.

17. I have not succeeded in discovering any clear relation between the times of occurrence of Irregularities of Westerly Force and of Northerly Force. They certainly do not coincide. In their intermixture, I cannot assert that an Irregularity of one element always occurs between two of the other element, though there is a general appearance of that law.

18. It appeared to me possible that an Irregularity of Nadir Force might occur at the change between + and − Irregularities of Westerly Force; and the following examination seems to show a certain degree of plausibility in the supposition:—

| Day. | Total Number of Nadir Irregularities. | Number of Nadir Irregularities corresponding to changes of sign for Westerly Irregularities. |
|---|---|---|
| 1841. Sept. 25 | 61 | 52 |
| 1847. Sept. 24 | 119 | 76 |
| Oct. 23 | 60 | 36 |
| 24 | 94 | 66 |
| Dec. 17 | 36 | 20 |
| 1851. Sept. 4 | 42 | 26 |
| 7 | 86 | 68 |
| 29 | 67 | 50 |
| 1852. Feb. 15 | 53 | 42 |
| 17 | 124 | 101 |
| 18 | 54 | 42 |
| 19 | 100 | 68 |
| June 11 | 32 | 22 |
| Dec. 11 | 20 | 14 |
| 1853. Mar. 8 | 11 | 8 |
| May 2 | 15 | 12 |
| 3 | 21 | 13 |
| 24 | 37 | 25 |
| July 12 | 34 | 25 |
| Sept. 1 | 13 | 9 |
| 2 | 36 | 25 |
| Oct. 25 | 10 | 9 |
| Dec. 6 | 26 | 23 |
| 1854. Feb. 24 | 21 | 16 |
| April 10 | 52 | 35 |
| 1855. Mar. 12 | 23 | 16 |
| 1857. May 7 | 58 | 39 |
| Sept. 3 | 37 | 31 |
| Dec. 17 | 30 | 21 |
| Total | 1372 | 990 |

19. The investigations which I had proposed to myself as more peculiarly the object of this paper are now terminated, in so far as their results can be comprehended in tables of numerical values and remarks on the relations between the numbers. But I think it desirable to subjoin Tables tending to exhibit the laws of frequency of the great wave-disturbances and the irregularities, with respect to the months of the year and with respect to the hours of the day.

20. First, for the months of the year. The following numbers are formed by simply collecting from Tables I., IV., and VII. all the numbers arranged in groups under each nominal month. It will be seen at once that the distribution of magnetic storms through the year is so irregular that, even in the long period of seventeen years, no inference can be drawn connecting the Magnetic Storms with the Seasons.

TABLE X.—Aggregates of Fluctuations and Inequalities, arranged by Months, in terms of the Horizontal Force.

| Month. | Westerly Force. | | | Northerly Force. | | | Nadir Force. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Algebraical Aggregate of Fluctuations. | Absolute Aggregate of Fluctuations. | Sum of Irregularities. | Algebraical Aggregate of Fluctuations. | Absolute Aggregate of Fluctuations. | Sum of Irregularities. | Algebraical Aggregate of Fluctuations. | Absolute Aggregate of Fluctuations. | Sum of Irregularities. |
| January ...... | − ·0435 | ·3183 | ·3492 | + ·0679 | ·4827 | ·3169 | − ·5582 | ·6250 | ·0662 |
| February ... | − ·1425 | ·6275 | 1·2093 | − ·5521 | 1·0223 | 1·3985 | − ·1176 | 2·4732 | ·5974 |
| March ...... | − ·1279 | ·3905 | ·6038 | − ·5193 | ·6071 | ·5640 | +1·0271 | 2·0367 | ·2158 |
| April ......... | + ·0289 | ·2635 | ·3192 | − ·4074 | ·4596 | ·4330 | − ·2766 | ·5416 | ·1341 |
| May ......... | − ·0266 | ·3052 | ·3533 | − ·0554 | ·4638 | ·5411 | + ·6293 | 1·9545 | ·2291 |
| June ......... | − ·0453 | ·1471 | ·1533 | − ·0224 | ·1674 | ·1706 | − ·9723 | ·5841 | ·0522 |
| July ......... | − ·0598 | ·2238 | ·3114 | − ·2361 | ·4187 | ·4414 | + ·0109 | ·4423 | ·1430 |
| August ...... | + ·0087 | ·0875 | ·0702 | − ·0135 | ·0427 | ·0859 | − ·0988 | ·1294 | ·0312 |
| September... | − ·1198 | ·7046 | 1·1977 | − ·4614 | 1·0812 | 1·3994 | − ·1785 | 2·2337 | ·9391 |
| October ...... | + ·0066 | ·5864 | ·8836 | − ·8129 | ·9881 | 1·0282 | − ·2781 | 1·8979 | ·4866 |
| November ... | − ·0431 | ·6511 | ·6016 | − ·6096 | ·7150 | ·6836 | − ·5549 | ·9893 | ·3744 |
| December ... | − ·1032 | ·4860 | 1·0726 | − ·7603 | ·9448 | ·9799 | − ·0969 | 1·1105 | ·2516 |

The disproportion of Irregularities to Fluctuations in the Nadir Force, as compared to those in the other Forces, is very remarkable.

21. Secondly, for the hours of the day. For each hour, on a day of storm, the nearest value of wave-disturbance (not of fluctuation) and the nearest value of irregularity were taken from the sheets in which the reductions described in Article 5 were made; and all the numbers thus found were collected for each hour, the + and − values of wave-disturbance being placed in separate columns. Thus the following Table is formed.

TABLE XI.—Sums of Wave-disturbances and of Irregularities, arranged by hours of Göttingen Solar Time, in terms of Horizontal Force.

| Hour of Göttingen Time. | Westerly Force. | | | | Northerly Force. | | | | Nadir Force. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of Measures. | Sums of Wave-disturbance. + | Sums of Wave-disturbance. − | Sums of Irregularities. | Number of Measures. | Sums of Wave-disturbance. + | Sums of Wave-disturbance. − | Sums of Irregularities. | Number of Measures. | Sums of Wave-disturbance. + | Sums of Wave-disturbance. − | Sums of Irregularities. |
| 0 | 25 | ·0201 | ·0103 | ·0213 | 29 | ·0136 | ·0717 | ·0323 | 5 | ·0285 | ·0000 | ·0090 |
| 1 | 56 | ·0558 | ·0106 | ·0416 | 57 | ·0339 | ·0726 | ·0674 | 19 | ·0681 | ·0306 | ·0236 |
| 2 | 77 | ·0658 | ·0203 | ·0658 | 82 | ·0617 | ·0900 | ·0954 | 33 | ·1434 | ·0455 | ·0370 |
| 3 | 76 | ·0881 | ·0224 | ·0725 | 92 | ·1060 | ·0807 | ·1060 | 40 | ·1773 | ·1131 | ·0563 |
| 4 | 98 | ·1051 | ·0334 | ·1144 | 108 | ·1201 | ·0823 | ·1462 | 63 | ·3094 | ·1187 | ·0774 |
| 5 | 95 | ·0831 | ·0437 | ·1179 | 103 | ·1407 | ·1019 | ·1233 | 60 | ·2832 | ·1113 | ·0681 |
| 6 | 105 | ·0752 | ·0713 | ·1327 | 114 | ·1276 | ·1291 | ·1290 | 74 | ·3701 | ·0856 | ·0794 |
| 7 | 104 | ·0593 | ·1079 | ·1353 | 108 | ·0806 | ·1422 | ·1344 | 77 | ·3976 | ·0974 | ·0915 |
| 8 | 122 | ·0331 | ·1759 | ·1746 | 136 | ·0570 | ·2171 | ·1754 | 79 | ·3092 | ·1280 | ·0853 |
| 9 | 126 | ·0276 | ·1848 | ·1743 | 119 | ·0479 | ·2393 | ·1439 | 80 | ·2866 | ·1575 | ·1169 |
| 10 | 123 | ·0165 | ·2191 | ·1976 | 130 | ·0553 | ·2612 | ·1750 | 86 | ·2529 | ·2061 | ·1241 |
| 11 | 116 | ·0267 | ·1841 | ·1531 | 111 | ·0544 | ·2747 | ·1524 | 77 | ·2110 | ·2837 | ·0889 |
| 12 | 121 | ·0278 | ·2070 | ·1429 | 122 | ·0449 | ·2917 | ·1422 | 74 | ·1629 | ·2716 | ·1007 |
| 13 | 111 | ·0277 | ·2036 | ·1606 | 108 | ·0307 | ·2470 | ·1429 | 63 | ·1097 | ·2830 | ·0799 |
| 14 | 112 | ·0442 | ·1574 | ·1442 | 109 | ·0308 | ·2897 | ·1260 | 74 | ·1768 | ·3133 | ·0941 |
| 15 | 99 | ·0601 | ·1324 | ·1604 | 100 | ·0362 | ·2194 | ·1443 | 59 | ·1329 | ·2598 | ·0717 |
| 16 | 102 | ·0537 | ·0951 | ·1359 | 97 | ·0160 | ·2428 | ·1287 | 59 | ·0966 | ·2881 | ·0825 |
| 17 | 84 | ·0695 | ·0508 | ·0926 | 86 | ·0120 | ·2137 | ·1117 | 54 | ·0910 | ·2963 | ·0619 |
| 18 | 87 | ·1016 | ·0315 | ·0970 | 93 | ·0101 | ·2043 | ·1169 | 46 | ·1010 | ·2038 | ·0532 |
| 19 | 76 | ·1008 | ·0193 | ·0793 | 85 | ·0112 | ·2531 | ·0990 | 44 | ·0830 | ·1889 | ·0470 |
| 20 | 75 | ·1170 | ·0107 | ·0826 | 81 | ·0076 | ·2646 | ·0713 | 39 | ·0614 | ·1295 | ·0427 |
| 21 | 58 | ·0613 | ·0083 | ·0527 | 65 | ·0087 | ·1919 | ·0694 | 29 | ·0619 | ·0740 | ·0306 |
| 22 | 59 | ·0647 | ·0179 | ·0520 | 69 | ·0038 | ·2241 | ·0694 | 26 | ·0355 | ·0460 | ·0270 |
| 23 | 51 | ·0460 | ·0214 | ·0346 | 57 | ·0052 | ·1463 | ·0441 | 24 | ·0491 | ·0396 | ·0177 |

It must be remarked here that the number of measures at $0^h$ is made in this Table unfairly small. This arises partly from the interruptions which are almost unavoidable in the operation of changing the photographic sheets at $0^h$, and partly from the manner in which the measured quantities have been treated in the discussion of Storms. When a storm has evidently occupied a part of a day, it has been usual to treat by rule the measures of the entire sheet of that day, from $0^h$ to $24^h$; and in that process, as is described in the beginning of Article 5, the two first and two last measures are lost; and some of these ought, in a great number of cases, to be referred to $0^h$. The best value that can be taken for $0^h$ will be the mean of the values for $23^h$ and for $1^h$.

22. It will be seen that, at the same hour, the mean value of Irregularity is nearly the same for the three Forces, but that, from hour to hour, the mean Irregularities are largest where the number of measures is greatest, that is, where storms are most frequent. In regard to the Wave-disturbance; for Westerly Force, the aggregate is + from $17^h$ to $6^h$, — from $7^h$ to $16^h$; for Northerly Force, the aggregate is + from $3^h$ to $5^h$, — from $6^h$ to $2^h$; and for Nadir Force, the aggregate is + from $23^h$ to $10^h$, — from $11^h$ to $22^h$. In regard to the modification which these Wave-disturbances might be supposed to produce on the laws of Diurnal Inequality, when it is remarked that each

of the hours $0^h$, $1^h$, $2^h$, &c. has been repeated $17 \times 365$ times, it will be seen that the introduction of these Storm Days into the general mass of observations will in no instance alter the mean Diurnal Inequality by a unit in the fourth decimal place. In a year of very great disturbance, as 1853, they may possibly introduce a correction of one unit, or perhaps two units, in the fourth decimal of some of the Diurnal numbers.

23. The import of the numbers of the last Table will be best seen by the following treatment. If for either of the three directions of force, at any one hour, we form the Algebraic sum of the + and − sums of wave-disturbances, and divide by the number of measures, we obtain the mean wave-disturbance whenever a storm occurs at that hour. If we form the Absolute sum, and divide it similarly, we obtain the double average departure from that mean whenever a storm occurs at that hour. The mean Irregularity is obtained by simple division.

TABLE XII.—Frequency of Storms, mean Wave-disturbance, average departure from the mean, and mean Irregularity, in terms of the Horizontal Force, at each hour of Göttingen Solar Time.

| Hour of Göttingen Time. | Westerly Force. | | | | Northerly Force. | | | | Nadir Force. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Frequency of Storms. | Mean Wave-disturbance. | Average departure from Mean. ± | Mean Irregularity. ± | Frequency of Storms. | Mean Wave-disturbance. | Average departure from Mean. ± | Mean Irregularity. ± | Frequency of Storms. | Mean Wave-disturbance. | Average departure from Mean. ± | Mean Irregularity. ± |
| 0 | 54 | + ·00039 | ·00061 | ·00085 | 57 | − ·00200 | ·00147 | ·00112 | 22 | + ·00570 | ·00285 | ·00180 |
| 1 | 56 | + 81 | 59 | 74 | 57 | − 68 | 93 | 118 | 19 | + 197 | 260 | 124 |
| 2 | 77 | + 59 | 56 | 86 | 82 | − 35 | 93 | 116 | 33 | + 297 | 286 | 112 |
| 3 | 76 | + 86 | 73 | 95 | 92 | + 28 | 101 | 115 | 40 | + 161 | 363 | 140 |
| 4 | 98 | + 73 | 71 | 117 | 108 | + 35 | 94 | 135 | 63 | + 303 | 340 | 123 |
| 5 | 95 | + 42 | 67 | 124 | 103 | + 38 | 118 | 120 | 60 | + 287 | 329 | 114 |
| 6 | 105 | + 4 | 70 | 126 | 114 | − 1 | 113 | 113 | 74 | + 385 | 308 | 107 |
| 7 | 104 | − 47 | 80 | 130 | 108 | − 57 | 103 | 124 | 77 | + 390 | 321 | 119 |
| 8 | 122 | − 117 | 86 | 143 | 136 | − 118 | 101 | 129 | 79 | + 229 | 276 | 108 |
| 9 | 126 | − 125 | 84 | 138 | 119 | − 161 | 121 | 121 | 80 | + 161 | 278 | 146 |
| 10 | 123 | − 165 | 96 | 161 | 130 | − 158 | 122 | 135 | 86 | + 54 | 267 | 144 |
| 11 | 116 | − 136 | 91 | 132 | 111 | − 198 | 148 | 137 | 77 | − 94 | 321 | 116 |
| 12 | 121 | − 148 | 97 | 118 | 122 | − 202 | 138 | 117 | 74 | − 147 | 294 | 136 |
| 13 | 111 | − 159 | 104 | 145 | 108 | − 200 | 129 | 132 | 63 | − 275 | 312 | 127 |
| 14 | 112 | − 101 | 90 | 129 | 109 | − 238 | 147 | 116 | 74 | − 185 | 331 | 127 |
| 15 | 99 | − 73 | 97 | 162 | 100 | − 183 | 128 | 144 | 59 | − 215 | 333 | 122 |
| 16 | 102 | − 41 | 73 | 133 | 97 | − 234 | 133 | 133 | 59 | − 325 | 326 | 140 |
| 17 | 84 | + 22 | 72 | 110 | 86 | − 235 | 131 | 130 | 54 | − 380 | 359 | 115 |
| 18 | 87 | + 81 | 77 | 112 | 93 | − 209 | 115 | 126 | 46 | − 224 | 331 | 116 |
| 19 | 76 | + 107 | 79 | 104 | 85 | − 285 | 155 | 117 | 44 | − 241 | 309 | 107 |
| 20 | 75 | + 142 | 85 | 110 | 81 | − 317 | 168 | 88 | 39 | − 175 | 245 | 110 |
| 21 | 58 | + 91 | 60 | 91 | 65 | − 281 | 154 | 107 | 29 | − 42 | 234 | 106 |
| 22 | 59 | + 79 | 70 | 88 | 69 | − 319 | 165 | 101 | 26 | − 40 | 157 | 104 |
| 23 | 51 | + 48 | 66 | 68 | 57 | − 248 | 133 | 77 | 24 | + 40 | 185 | 74 |

The Soli-tidal character of the principal characteristics of the occasional Magnetic Storms, as to frequency, magnitude, inequalities of wave-disturbance, and Irregularities, is seen clearly in this Table.

24. I now come to the consideration of the physical inference from these numerical conclusions. And first I would remark that I do not think that they can be reconciled with the supposition of definite galvanic currents or definite magnets, suddenly produced, in any locality whatever, as sufficient to explain the disturbances observed here. On that hypothesis, it would seem necessary to believe that such sudden currents or magnets would produce simultaneous disturbances in the three co-ordinate directions, that, if the long period of a wave permitted some deviation from this rule, yet the short period of an inequality would admit of no such deviation, and that, on any supposition, the number of disturbances in the three directions would be approximately equal. Yet in fact we find that neither in Waves nor in Irregularities is there the least appearance of simultaneity, and that, though there is close equality of numbers between the Westerly and Northerly Forces, yet the Nadir Force (in which the Irregularities are as strongly marked as in the Westerly and Northerly, and the Wave-disturbances much more strongly marked) exhibits less than half the number. These considerations appear to me quite conclusive as showing that the observed disturbances cannot be produced by the forces of any suddenly created galvanic current or polar magnet.

25. To suggest instead of this an imperfect conjecture, based upon grounds so inadequate as those which we can at present use for its foundation, must be a delicate and dangerous, I may almost say an invidious enterprise. Yet the impression of an explanation of broad character, partly definite but generally indefinite, has, in the course of this investigation, forced itself so strongly on my mind, that I should think it wrong to omit to describe it. Its fundamental idea is, that there may be in proximity to the earth something which (to avoid unnecessary words) I shall call a Magnetic Ether; that under circumstances generally, but not always, having reference to the solar hour, and therefore probably depending on the sun's radiation or on its suppression, a current from N.N.W. to S.S.E., approximately, or from S.S.E. to N.N.W. (according to the boreal or austral nature of the ether) is formed in this Ether; that this current is liable to interruptions or perversions of the same kind as those which we are able to observe in currents of air and water; and that their effect is generally similar, producing eddies and whirls, of violence sometimes far exceeding that of the general current from which they are derived.

26. Our powers of observing the two elements to which I have referred for analogy are somewhat different, but both imperfect. We know that in a gale of wind, the direction of the wind is continually changing; the horizontal pressure and the barometric pressure also are continually changing; but the changes are so rapid that we cannot easily determine whether there is any correspondence between them. But, in the storms on a large scale, there is reason to think that some winds are radial, but far more are cyclonic; that in some instances the barometer rises in the centre, but in more it is depressed; and in many instances the disturbance of vertical pressure is enormous (for 1 inch of barometer corresponds to a pressure of about 70 lbs. per square foot). Of water, perhaps the best study is to be found in disturbed tidal currents, as those of the

Western Islands of Scotland; here, in some places, approximately circular spaces are to be seen which are quiet, but which appear to the eye to be elevated above the rest; in some disturbed places the water is thrown upwards; in other places the sea is whirling round with great speed, in a good circular form, and with a funnel of considerable depth in the centre; in other places, boiling currents are running very fast in opposite directions, though separated by no great space; the general impression however is that of circularity*; great circles and small circles coexisting. Though these circular forms may be more prevalent in one part of the sea than another, they are not fixed, but wander irregularly, sometimes suddenly disappearing, and sometimes as suddenly created anew. In like manner, in the course of a river, travelling funnels may be seen, whose depth sometimes exceeds their breadth.

27. Now it appears to me that if a sentient and reasoning being were immersed either in the air or in the water through which these circles are wandering, he would perceive actions nearly similar to those which we have found to exist in the magnetic storms. The large and slowly-displaced circles would produce Wave-disturbances, slowly changing their direction, and thus having different times of evanescence in the N. and S. direction (on the one hand) and in the E. and W. direction (on the other hand); the smaller circles, in like manner, would produce the rapid Irregularities. And in the relation between E. and W. disturbances and vertical disturbances, there is a point which well deserves attention. When a water-funnel passed nearly over the observer, travelling (suppose) in a N. direction, he would first experience a strong current to the E., afterwards a strong current to the W. (or *vice versâ*), and between these there would be a very strong vertical pressure in one direction, not accompanied by one in the opposite direction; thus he would have half as many vertical as horizontal impulses. This state of things corresponds to the proportion which we have found throughout for the magnetic disturbances, and to the relation found in Article 18. I may also add that the rule at which we have arrived, that the waves of vertical force are few, but that their power, when they do occur, is very great, seems to correspond to what is reported of the whirlwinds of great atmospheric storms; which, violent and even frequent as they may be, occur very rarely at any assigned place.

28. It seems to me that there is so much plausibility in these suppositions as to justify me in expressing a wish that some effort might be made to verify them. The immediate object of observations would be, to ascertain through a locality of considerable extent the times and magnitudes of Wave-disturbances and of Irregularities on the same days throughout, with the view of discovering whether they could be collectively represented as the effects of such travelling vortices as I have suggested. In regard to the extent of the locality, I should think that a portion of the Continent of Europe would suffice, and that five or six magnetic observatories would decide the points under inquiry. In regard to the mode of observation, though eye-observation is, for a limited time, the most accurate, yet self-registering record is the only method which can insure the

* I have been upon these currents, and in close proximity to these whirlpools.

observation of all that is required; only, I would specially observe, it is indispensable that eye-observations be used to check the zeros of time and of measure, and that the photographic traces be so strong that they will not be lost in rapid motions of the magnet. In regard to the mode of primary reduction, I imagine that the method followed in this Memoir (with such small alterations as experience may suggest) will be found best.

*** The computations for the "Diurnal Inequalities" were performed by computers under the immediate superintendence of Mr. John Lucas; some portions of them were revised and corrected by James Glaisher, Esq., F.R.S., Superintendent of the Magnetical and Meteorological Department of the Royal Observatory. The curves were drawn under Mr. Glaisher's superintendence by Mr. W. C. Nash, and reduced to scale by Mr. James Carpenter, Assistant in the Astronomical Department of the Royal Observatory. The computations of the present Memoir were made under the superintendence of Mr. Glaisher, by Mr. Nash and junior computers.